Register Number :

QP-Code : 20ME11T

Makeup Examination Nov/Dec - 2022

I Semester Diploma Examination

MATERIALS FOR ENGINEERING (20ME11T)

Time: 3 Hours] **[Max. Marks: 100**

Instruction: i) Answer ONE full question from each section.

ii) One full question carries 20 marks.

SECTION – I

1. (a) List any five applications of Engineering materials. (5)
   (b) Explain Face Centre Cubic (FCC) structure. (5)
   (c) List any five Mechanical properties of metals. (5)
   (d) Show the various parts of Transmission Electron Microscope with the help of diagram. (5)

2. (a) List any five types of corrosion. (5)
   (b) Show any two differences between electrolyte and non-electrolyte also list any three types of electrolytes. (5)
   (c) Explain the working of electrochemical cell with the help of diagram. (5)
   (d) Analyze surface coating through electrolysis with the help of setup diagram. (5)

SECTION-II

3. **(a)** Mention the classification of Alloy steel. (6)

   (b) Indicate the meaning of following designations. (6)
   (i) FeE250 (ii) 65C4 (iii) Fe200

   (c) Mention the type of Steel used for following applications and justify your answer. (8)
   (i) Shaft (ii) Bolts & Nuts

OR

4. **(a)** List different types of Stainless steel. (4)

   (b) Explain Nodular Cast Iron with a sketch showing the graphite appearance. (6)

   (c) Suggest a type of tool steel for making following tools. Also mention their properties. (10)
   i) Lathe tools & Drill bits ii) Blanking dies

SECTION – III

5. (a) Difference between Ferrous and Non-Ferrous metals. **(10)**
   (b) State any five properties and uses of Brass. **(10)**

6. (a) List Nickel alloys and explain properties and applications of Nickel. **(10)**
   (b) Mention the types of bearing materials. Explain any six properties. **(10)**

SECTION – IV

7. a) List any four applications of smart materials **(4)**
   b) Differentiate between thermosetting and thermoplastic materials **(10)**
   c) Suggest an advanced material for medical application, justify **(6)**

8. a) List any four applications of nano materials **(4)**
   b) Sketch Iron-Carbon equilibrium diagram indicating various phases **(10)**
   c) What are the different types of heat treatment process **(6)**

SECTION – V

9. (a) State the purpose of heat treatment. **(6)**
   (b) Discuss Annealing and hardening heat treatment processes. **(8)**
   (c) Differentiate between Carburising and Nitriding heat treatment processes **(6)**

10. (a) List the different types of corrosion. **(5)**
    (b) With neat sketch explain Electroplating process. **(10)**
    (c) What are electrolytes? And mention different types of electrolytes. **(5)**

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MATERIALS FOR ENGINEERING (20ME11T)

Scheme and answer

Course: Materials for Engineering **Course Code: 20ME11T**

Q. NO.		QUESTION	MARKS
SECTION - 1			
1.	**a**	Any general five applications	5*1=5M
	b	Brief explanation Figure	3M 2M
	c	Any five properties	5*1=5M
	d	Simple diagram with labels	5M
2	**a**	Any five types	5*1=5M
	b	Two differences Three types	2M 3M
	c	Brief explanation Diagram	2M 3M
	d	Brief explanation Setup diagram	2M 3M
SECTION - 2			
3	**a**	Mention the classification of Alloy Steel	1*6=6M
	b	Writing the designation for (i) + (ii) + (iii)	2+2+2=6M
	c	i) Mentioning the Steel type + Justification ii) Mentioning the Steel type + Justification	(2+2) + (2+2) = 8M
4	**a**	Listing the different types of Stainless steel	1*4=4M
	b	Sketch + explanation for Nodular cast iron	3+3=6M
	c	(i) Mentioning the type of Tool steel + Properties (ii) (ii) Mentioning the type of Tool steel + Properties	(2+3) + (2+3) = 10M
SECTION - 3			
5	**a**	Any 5	5*2=10M
	b	Any 5 Properties 5 Any 5 Uses 5	5*1=5M 5*1=5M
6	**a**	List any 4 Any 4 Properties Any 4 Applications	1/2*4=2M 4*1=4M 4*1=4M

	b	Types of Bearing Materials Any 6 Properties of Bearing Materials	4*1=4M 6*1=6M
SECTION - 4			
7	**a**	Any four applications	1*4=4M
	b	Any 5 points of Thermosetting Any 5 points of Thermoplastics	1*5=5M 1*5=5M
	c	Suggest Justify	3M 3M
8	**a**	Any four applications	1*4=4M
	b	Sketch Iron-Carbon equilibrium diagram indicating various phases	5+5=10M
	c	Any 6 types	6M
SECTION - 5			
9	**a**	State the purpose of heat treatment.	6M
	b	Discuss Annealing and hardening heat treatment processes.	4+4=8M
	c	Differentiate between Carburising and Nitriding heat treatment processes.	3+3=6M
10	**a**	List the different types of corrosion.	5M
	b	With neat sketch explain Electroplating process.	4+6=10M
	c	Definition and mentioning different types of electrolytes.	5M

SECTION – 1

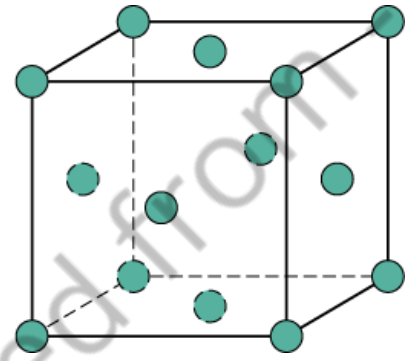
1(a) List any five applications of engineering materials.

Applications of Engineering Materials are as follows:

- Steel materials are used for production of bars, channels, machineries etc.
- Steel alloys are used for tools, dies, automobile parts etc.
- Copper is used in wires, heating element, etc.
- Aluminium is used for windows, frames, domestic articles etc.
- Used in construction.
- Used in vehicles, ships and airplanes.
- Used in electronic equipment.

1(b) Explain Face Centre Cubic (FCC) structure.

- In FCC type of structure, the unit cell which is in the shape of a cube contains one atom at each of its 8 corners and one atom at the centre of each of its face.
- This type of structure does not contain any atom at the centre of the unit cell.
- In this type each unit cell shares 14 (8+6) atoms, with the neighbouring unit cells.
- This type of unit cell is found in metals like γ-iron (910° C to 1440° C), Copper, Silver, Gold, Aluminium, Nickel, Lead and Platinum, etc.

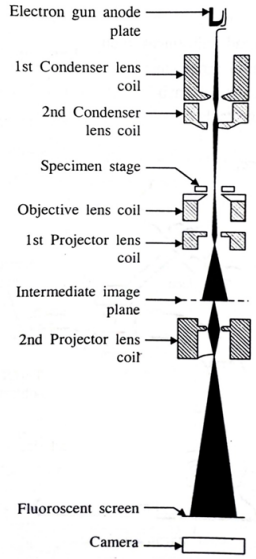


1(c) List any five Mechanical properties of metals.

- Elasticity
- Plasticity
- Ductility
- Brittleness
- Hardness
- Toughness
- Stiffness
- Resilience
- Malleability
- Creep
- Endurance
- Strength

1(d) Show the various parts of Transmission Electron Microscope with the help of diagram.

Transmission Electron Microscope:



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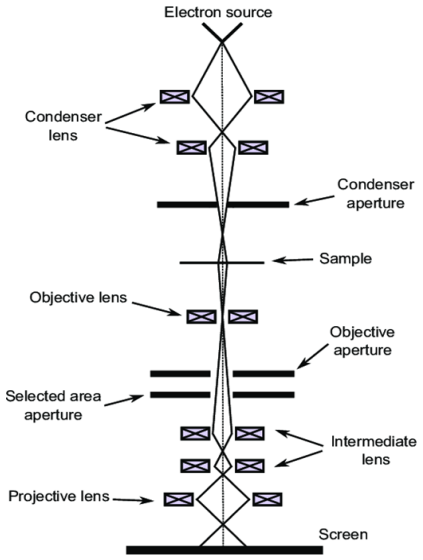


2(a) List any five types of corrosion.

- Uniform corrosion
- Pitting corrosion
- Intergranular corrosion
- Stress corrosion
- Crevice corrosion
- Season corrosion
- Fatigue corrosion
- Atmospheric corrosion
- Erosion corrosion
- Under-ground corrosion
- Fretting corrosion
- Selective corrosion.

2(b) Show any two differences between electrolyte and non-electrolyte also list any three types of electrolytes.

Differences between electrolyte and non-electrolyte:

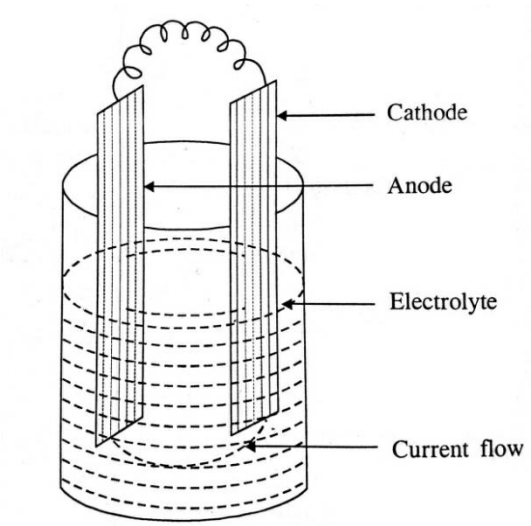
Sl No	Electrolyte	Non-electrolyte
1	Electrolytes are chemical compounds that conduct electricity when dissolved in an aqueous solution.	Non-electrolytes are chemical compounds that do not conduct electricity when dissolved in an aqueous solution.
2	They have ionic bond.	They have covalent bond.
3	Ions are present.	Ions are not present.
4	Example: Acids, Bases and Salts, etc.	Example: Sugar, glucose, ethyl alcohol, urea, etc.

Following are the different types of electrolytes:

- Sodium
- Potassium
- Calcium
- Bicarbonate
- Magnesium
- Chloride and phosphate etc.

2(c) Explain the working of electrochemical cell with the help of diagram.

Electrochemical cell:

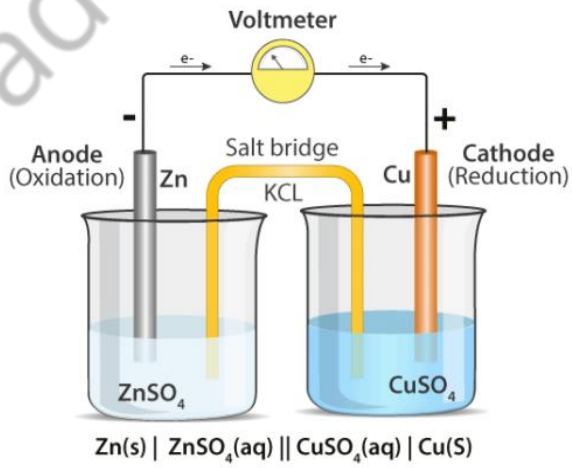


Working of an Electrochemical Cell:

- In this cell, the two principal reactions take place one at the cathode and another at the anode.
- The reactions taking place at the anode (known as anodic reaction) are always oxidation reactions.
- These reactions always tend to destroy the anode metal by causing it to dissolve in the electrolyte and gets deposited over the cathodic metal and forms the coating over that metal.
- The reactions taking place at the cathode (known as cathodic reaction) are always reductions reactions.
- These reactions, usually, do not affect the cathode metal, because most of the metals cannot be reduced further.
- The electrons, which are produced by the anodic reaction flow through the metal, are used up in the cathodic reaction.

OR

Electrochemical cell:



Working of an Electrochemical Cell:

- Let us use the redox reaction given below to explain the construction of an Electrochemical Cell.

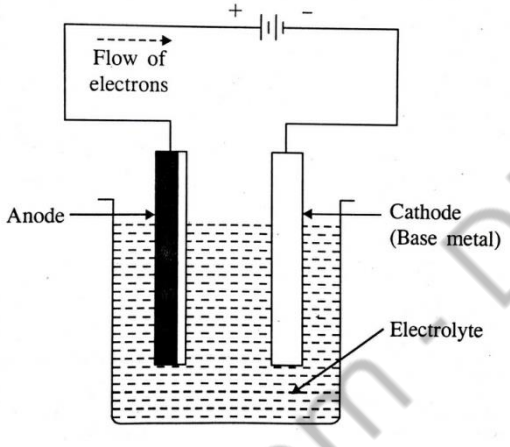
- $Zn(Solid) + CuSO^4(Aqueous) \rightarrow ZnSO^4(Aqueous) + Cu\ (Solid)$
- The ionic form of the reaction is: $Zn + Cu^2 + Zn^{2+} + Cu$

This reaction can be split into the following two half reactions.

i. Oxidation half reaction: $Zn \rightarrow Zn^{2+} + 2e^-$
ii. Reduction half reaction: $Cu^{2+} + 2e^- \rightarrow Cu$

- The oxidation reaction in the zinc rod releases two electrons.
- These two electrons are taken by the Copper ion in the copper sulphate solution.
- If these two half reactions can be separated, then the electrons can be made to move through a wire.
- In this manner we can produce electrical energy from chemical energy.
- The salt bridge is a concentrated solution of inert electrolytes.
- It is required for completing the circuit. It allows the movement of ions from one solution to the other.

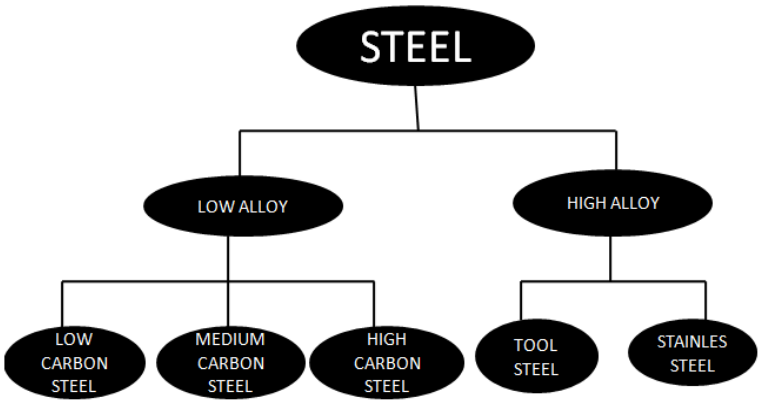
2(d) Analyze surface coating through electrolysis with the help of setup diagram.
Surface Coating through Electrolysis - Setup:



- It is a process of depositing a very thin layer of metal coating, on the base metal by passing the direct current through an electrolyte.
- Solution containing some salt of a coating metal.
- In this process, the component of base metal is made to act as a cathode whereas the coating metal as an anode in a solution containing some salt of coating metal i.e. electrolyte as shown in fig.
- Now direct is passed for a known time to obtain the coating of desired thickness on a base metal.
- When the current is passed the metal at the anode starts dissolving in the solution due to the anodic reaction, the dissolved metal (electrolyte) gets deposited over the base metal at the cathode.
- The thickness of coating is depends upon the time up to which the current is passing.
- The commonly used metals, which are used as a protective coating i.e. electrolyte are copper, nickel, silver, gold, chromium, cadmium and tungsten etc.

SECTION – 2

3 (a) Mention the classification of Alloy steel.



3 (b) Indicate the meaning of following designations.
(i) FeE250 (ii) 65C4 (iii) Fe200

(i) FeE250 : Steel with a Yield strength of 250 N/mm^2

(ii) 65C4 : Plain carbon steel with 0.65% Carbon and 0.04 % Manganese

(iii) Fe200 : Steel with Tensile strength of 200 N/mm^2

3 (c) Mention the type of Steel used for following applications and justify your answer.
(i) Shaft (ii) Bolts & Nuts

(i) Shaft

Mild or low-carbon steel is used for shafts.

Low carbon steel has following desirable properties for making Shafts.

- High fatigue strength.
- Good machinability.
- High Ductility
- Outstanding toughness.

(ii) Bolts & Nuts

Low carbon steel *OR* Stainless Steel is used for Bolts & Nuts.

Low carbon steel has following desirable properties for making **Bolts & Nuts**.

- High fatigue strength.
- Good machinability.
- High Ductility
- Outstanding toughness

Stainless Steel has following desirable properties for making Bolts & Nuts:

- Great resistance to corrosion
- Good Torsional strength
- Good surface hardness
- Superior strength and toughness

OR

4(a) List different types of Stainless steel.

Following are the different types of Stainless steel;

(i) Austenitic Stainless Steels

(ii) Martensitic Stainless Steels
(iii) Ferritic Stainless Steels
(iv) Low Chromium Stainless Steels

4(b) Explain Nodular Cast Iron with a sketch showing the graphite appearance.

Characteristics

- Graphite appears as rounded particles or Nodules or Spheroidal
- The properties of nodular cast iron depend upon the metal composition and the cooling rate.
- It possesses very good machinability
- Soft annealed grades of nodular cast iron can be turned at a very high feeds and speeds.
- Nodular cast iron contains
  - 3.2 - 4.2% Carbon (C)
  - 1.1 - 3.5% Silicon (Si)
  - 0.3 – 0.8% Manganese (Mn)
  - 0.08% Phosphorus (P) and
  - 0.2% Sulphur (s)
- It possesses excellent damping capacity, castability and wear resistance

Applications:

1. Crank Shaft
2. Pipes
3. Spindle
4. Hypoid axle gears
5. Tractors

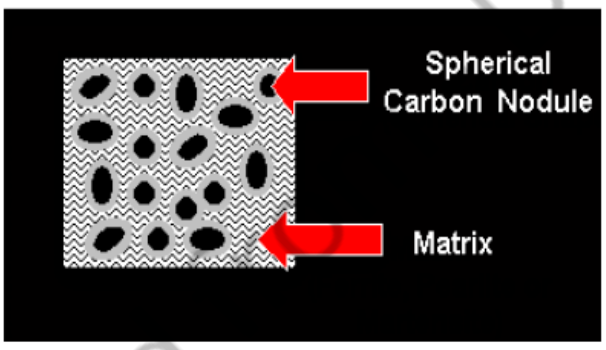


Figure: Nodular Cast Iron and the spherical carbon embedded into the matrix.

4 (c) Suggest a type of tool steel for making following tools. Also mention their properties.

i) Lathe tools & Drill bits ii) Blanking dies

Application	Type of Tool Steel	Properties
(i) Lathe tools & Drill bits	High-speed tool steels	High hardness High red hardness Wear resistance Reasonable toughness and good hardenability
(ii) Blanking dies	Cold work tool steels	very high abrasion and wear resistance higher toughness higher impact resistance

Section-3

5a. Difference between Ferrous & Non-Ferrous metals

Sl no	Ferrous Metals	Non-Ferrous metals
1	Ferrous indicates the presence of iron in a bivalent state.	Non-ferrous metals do not contain any iron.
2	As ferrous contains iron, it shows magnetic feature.	Non-ferrous metals don't show any magnetic feature which means it's non-magnetic.
3	Ferrous metals are less resistant to corrosion.	Non-ferrous metals are more resistant to corrosion
4	One special feature of ferrous metals is it possesses high tensile strength and durability.	One special feature of non-ferrous metals is their malleability.
5	Ferrous metals can be oxidized.	Non-ferrous metals cannot be oxidized.
6	Ferrous metal includes mild steel, carbon steel, stainless steel, cast iron and wrought iron.	Non-ferrous metals includes Aluminium, copper,Nickel, zinc etc.
7	Ferrous metals make up the most recycled materials in the world.	As per the recycling goes, many non-ferrous materials are relatively scarce.
8	Used where Strength is the Primary focal point.	Ideal for electronics & Electrical applications.
9	The price of ferrous metal tends to be lower.	Prices of non-ferrous metals are greater than ferrous metals.

5b. State any five properties and uses of Brass.

Brass is an alloy of copper and zinc, in which zinc is the principle alloying metal.

Properties of Brass:

i. Brass often has a bright gold appearance; however, it can also be reddish-gold or silvery-white. A higher percentage of copper yields a rosy tone, while more zinc makes the alloy appear silver.
ii. Brass has higher malleability than either bronze or zinc.
iii. Brass has desirable acoustic properties appropriate for use in musical instruments.
iv. The metal exhibits low friction.
v. The alloy has a relatively low melting point ranges from 800^0 C to 1000^0 C.
vi. It's a good conductor of heat & have low thermal and electrical conductivity
vii. Brass is easy to cast & can be easily fabricated.
viii. It has a greater strength than the copper.
ix. It has a good corrosion resistance.
x. It is soft and ductile.
xi. It is non-magnetic.

Applications/Uses of Brass:

i. It is used for hydraulic fitting and pump linings.
ii. Used for making utensils.
iii. Used for making bearings and bushes etc.
iv. Used for valves, automobile fittings, type writer parts.
v. Used for musical instruments.
vi. Used for cold rolled sheets, wire drawing pressing,
Vii For tube and plate manufacturing.

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6a. List Nickel alloys and explain properties and applications of Nickel.

Nickel Alloys

i.Monel ii Iconel iii Nichrome iv Nimonic

Properties:

i. Nickel is a silvery white metal capable of taking a high polish.
ii. Its specific gravity is 8.85 and its melting point is 1452^0 C.
iii. It is hard material.
iv. When it contains small amount of carbon, it is malleable.
v. It can be easily rolled.
vi. It resists the attacks of most of the acids.
vii. It dissolves readily in Nitric acid.
i. Small amount of magnesium improves the ductility considerably.

Applications

- It is used as an alloying metal in steels and cast irons.
- It is used as a coating material for steel, copper, brass etc.
- It is used for decorative purposes.
- It is used for corrosion protection purposes.

6b. Mention the types of bearing materials. Explain any six properties.

Bearing Materials

Following are the widely used bearing metals

i. Copper-base alloys
ii. Lead-base alloys
iii. Tin-base alloys
iv. Cadmium-base alloys.

Properties of Bearing Materials

- ✔ It should have low coefficient of friction.
- ✔ It should have good wearing qualities.
- ✔ It should have ability to withstand bearing pressures.
- ✔ It should have ability of operate satisfactorily with suitable lubrication means at the maximum rubbing speeds.
- ✔ It should have a sufficient melting point.
- ✔ It should have high thermal conductivity.
- ✔ It should have good casting qualities.
- ✔ It should have minimum shrinkage after casting.
- ✔ It should have non-corrosive properties.
- ✔ It should be economical in cost.

SECTION – 4

7 a) List any four applications of smart materials.

i. Aerospace
ii. Mass transit
iii. Marine
iv. Automotive
v. Computers and other electronic devices
vi. Consumer goods applications
vii. Civil engineering
viii. Medical equipment applications
ix. Rotating machinery applications

b) Differentiate between thermosetting and thermoplastic materials

Sl. No.	Thermoplastic plastic	Thermosetting plastic
1	It is linear polymer.	It is cross linked polymer.
2	It is soft and flexible.	It is hard and brittle.
3	It is formed by addition polymerization.	It formed by condensation polymerization.
4	It has low molecular weight.	It has high molecular weight.
5	It is not fire proof.	It is fire proof.
6	It can be reused.	It cannot be reused.
7	They undergo no chemical change in the moulding operation.	They undergo chemical change in the moulding operation.
8	They can be softened again and again.	They cannot be re-softened once they are hard.
9	They are affected by certain solvents.	They are unaffected by any solvents.

c) Suggest an advanced material for medical application, justify.

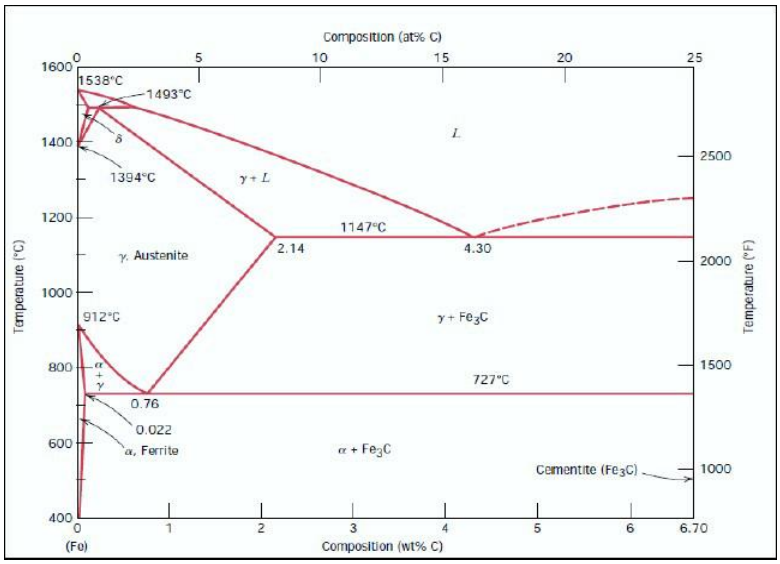
Biomaterials are suggested for Medical applications.

Biomaterials have following properties which are suitable for Medical applications;
1. They do not react with any tissue in the body.
2. They are non-toxic to the body.
3. Long term replacement won't be biodegradable.

8 a) List any four applications of nano materials.

a. Used in cell phones
b. Used in automobile industry
c. Used in 3-D printing parts
d. Used in paints
e. Used in sensors
f. Used in medicines

b) Sketch Iron-Carbon equilibrium diagram indicating various phases



c) What are the different types of heat treatment process

1. Annealing
2. Normalising
3. Hardening
4. Tempering
5. Case hardening.
    a) Carburising
    b) Cyaniding
    c) Nitriding
6. Surface hardening
    a) Induction hardening
    b) Flame hardening
7. Diffusion coatings.

Section-5

9. (a) State the purpose of heat treatment.

Answer: Heat treatment process is carried out for the following purpose.

1. To relieve internal stresses, which are set up in the metal due to cold or hot working.
2. To soften the metal.
3. To improve hardness of the metal surface.
4. To improve machinability.
5. To refine grain structure.
6. To improve mechanical properties like tensile strength, ductility and shock resistance.
7. To improve electrical and magnetic properties.
8. To increase resistance to wear, tear, heat and corrosion.

8. **(b) Discuss Annealing and hardening heat treatment processes.**
Answer: (i) **Annealing process:** Annealing is a process of heating the steel to a temperature near or above the critical temperature and holding at that temperature for a certain suitable period and then cooling it slowly in the furnace itself. The important purpose of annealing process is to make steel soft. Annealing process is classified into two

types namely full annealing and process annealing. **Full annealing:** This process consists of heating the steel, 300 c to 500 c above the upper critical temperature for hypoeutectoid steel and by the same temperature above the lower critical temperature for hypereutectoid steels. The steel is then held at this temperature for some time to enable the internal changes to take place. The time allowed is approximately 3 to 4 minutes for each millimetre of thickness of the largest section, and then slowly cooled in the furnace. The rate of cooling varies from 300c to 200c per hour, depending upon the composition of steel.

Process Annealing: In this process the steel is heated to a temperature below or close to the lower critical temperature, held at this temperature for some time and then cooled slowly.

(ii) **Hardening process:** Hardening is a process of heating the steel up to a temperature of 300 c to 500 c above the upper critical temperature for the hypoeutectoid steels and by the same temperature above the lower critical point for hypereutectoid steels. The steel is held at this temperature for a considerable time and then quenching in a suitable medium. The quenching medium may be water, brine solution, mineral oils and cool air. This rapid cooling causes the steel surface very hard and brittle. The process of hardening is of four types. Working hardening, Age hardening, Air hardening and Hardening by heating and quenching.

9. (c) Differentiate between Carburising and Nitriding heat treatment processes.

	Carburising	Nitriding
1	Treating the surface of steel with carbon	Treating the surface of steel with nitrogen
2	Steels are heated in contact with carbonaceous material ,like $BaCo_3$	Steels are heated with the atmosphere of ammonia.(NH_3)
3	Steels are quenched directly in oil, due to process temperature(900^0c to 950^0c)	Steels does not require quenching, because of low temperature process(450^0c to 550^0c)
4	This Process gives case depth of 0.8 to 1mm	This Process gives case depth of 0.8 mm
5	Surface hardness ranges from 62 to 64 HRC	Surface hardness is greater than 67 HRC

10. (a) List the different types of corrosion.

Answer: The main types of corrosion are as follows

(i) Direct chemical corrosion (Dry corrosion)

(ii) Electro-chemical corrosion (Wet corrosion)

Various types of corrosion are:

· Uniform corrosion
· Pitting corrosion
· Intergranular corrosion
· Stress corrosion
· Crevice corrosion
· Season corrosion
· Fatigue corrosion
· Atmospheric corrosion
· Erosion corrosion
· Underground corrosion
· Fretting corrosion
· Selective corrosion

10. (b) With neat sketch explain Electroplating process.

Answer:

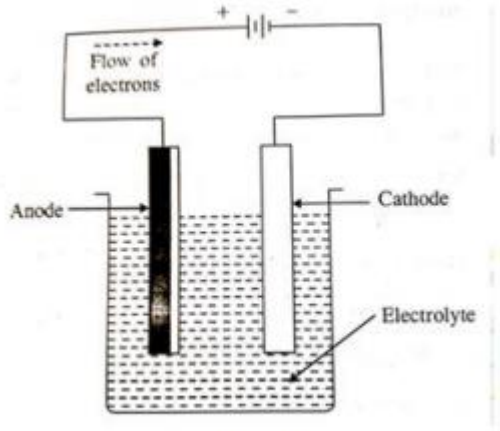


Fig: Electroplating

It is a process of depositing a very thin layer of metal coating, on the base metal by passing a direct current through an electrolytic solution containing some salt of the coating metal. Above figure illustrates a electroplating process here, the component of base metal is made to act as a cathode whereas the coating metal is an anode in a solution containing some salt of the coating metal i.e. electrolyte. A DC current is supplied to the anode that oxidizes the base metal atoms and dissolves them into the solution. The dissolved ions of base metal are deposited at the cathode and plated. The commonly used coating materials are copper, nickel, gold, chromium and tungsten

10. (c) What are electrolytes? And mention different types of electrolytes.

Answer: **Electrolytes:** An electrolyte is a substance that dissociates in water into charged particles called ions. Positively charged ions are called cations. Negatively charged ions are called anions. Simply, an electrolyte is a substance that can conduct an electric current when melted or dissolved in water. Ex: Acids, Bases and Salts are electrolyte.

Types of electrolytes:

(i)**Strong electrolyte:** The electrolytes that are almost completely disassociated into ions in solution are called strong electrolytes.

Ex: NaCl (Sodium chloride), KCl (Potassium Chloride), HCl (Hydro chloric acid), NaOH (Sodium hydroxide), etc.

(ii)Weak electrolyte: The electrolytes which do not completely disassociated into ions in solution are called weak electrolytes. Hence it is a poor conductor of electricity

Ex: H_2CO_3 (Carbonic acid), H_3PO_4 (Phosphoric acid), NH_3 (Ammonia), etc.