Code : 20ME11T

1399

Register Number

I Semester Diploma Examination, August/September-2022

MATERIALS FOR ENGINEERING

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

Instructions : (i) Answer any **one** full question from each Section.
(ii) **One** full question carries **20** marks.

SECTION – 1

1. (a) Classify Engineering materials with examples. **8**
   (b) List any six mechanical properties of metals. **6**
   (c) Sketch and explain FCC crystal structure. **6**

2. (a) Explain Ferrous and Non-ferrous metals with examples. **4**
   (b) Sketch and explain Transmission Electron Microscope (TEM). **8**
   (c) Sketch and label the parts of a Electro-Chemical cell. **8**

SECTION – 2

3. (a) List the different types of Cast Iron. **4**
   (b) Mention the types of metal used for making the following components and justify your answer : **8**
   (i) Agricultural Equipments
   (ii) Antifriction Bearings
   (c) Indicate the meaning of following designations : **8**
   (i) Fe 250 (ii) 55 C4
   (iii) FeE 300 (iv) BM 300

4. (a) Write the classification of steel. **6**
   (b) State the purpose of Alloying. **6**
   (c) Mention the type of stainless steel with its properties for following applications : **8**
   (i) Household utensils
   (ii) Surgical instruments

SECTION – 3

5.	(a)	Differentiate between Brass and Bronze.	6
	(b)	State any three (3) properties and two (2) uses of following metals :	10
		(i) Copper	
		(ii) Aluminium	
	(c)	Explain Self-lubricating bearings.	4
6.	(a)	Give classification of polymers.	10
	(b)	State any five properties of ceramics.	5
	(c)	Explain the designation of plastics.	5

SECTION – 4

7.	(a)	List any four (4) applications of Smart materials.	4
	(b)	Differentiate between Thermosetting and Thermoplastic materials.	10
	(c)	Suggest an advanced material for medical application. Justify your answer.	6
8.	(a)	Distinguish between interstitial and substitutional solid solution.	4
	(b)	Sketch Iron-Carbon Equilibrium diagram indicating various phases.	10
	(c)	List the different types of Heat treatment process.	6

SECTION – 5

9.	(a)	State the purpose of Heat treatment.	8
	(b)	Distinguish between Annealing and Normalizing.	8
	(c)	Suggest a suitable heat treatment process during the manufacturing of laminated springs. Justify your answer.	4
10.	(a)	List different types of corrosion.	4
	(b)	Differentiate between Electrolyte and Non-electrolyte.	6
	(c)	Explain with a neat sketch Electroplating process.	10

I SEM DIPLOMA EXAMINATION, AUGUST / SEPTEMBER 2022

MATERIALS FOR ENGINEERING (20ME11T)

SCHEME OF EVALUATION

Q. NO.		QUESTION	MARKS
SECTION - 1			
1.	**a**	Listing of 4 types of Engineering materials + any two examples for each type	(1*4)+(1*4)=8
	b	Listing of any Six (6) mechanical properties	1*6=6
	c	Sketch + explanation for FCC	3+3=6
2	**a**	Explanation + Examples for Ferrous and Non-ferrous metals	2+2=4
	b	Sketch + explanation for TEM	4+4=8
	c	Sketch + Labeling	4+4=8
SECTION - 2			
3	**a**	Listing of 4 types of Cast Iron	1*4=4
	b	i) Mentioning the metal name + Justification ii) Mentioning the metal name + Justification	(2+2) + (2+2) = 8
	c	Writing the designation for (i) + (ii) + (iii) + (iv)	2+2+2+2=8
4	**a**	Writing the classification of Steel	6
	b	Listing the purpose of Alloying	1*6=6
	c	(i) Mentioning the type of Stainless steel + Properties (ii) Mentioning the type of Stainless steel + Properties	(2+2) + (2+2) = 8
SECTION - 3			
5	**a**	Any 6 difference between Brass & Bronze	1*6 = 6
	b	(i) 3 properties + 2 uses of Copper (ii) 3 properties + 2 uses of Aluminium	(3+2) + (3+2) = 10
	c	Explanation	4
6	**a**	Mentioning the basis for classification + listing the types of Polymers	4+6 = 10
	b	Listing any 5 properties of Ceramics	1*5 = 5
	c	Explanation	5

SECTION - 4			
7	**a**	Listing any 4 application of Smart materials	1*4 = 4
	b	Differences between Thermosetting and thermoplastic **(Any 5)**	2*5 = 10
	c	Mentioning an Advanced material + Justification	3+3 = 6
8	**a**	Difference between Interstitial and Substitutional solid solution **(Any 2)**	2*2 = 4
	b	Iron carbon diagram sketch + Indication of various phases	5+5 = 10
	c	Listing of types of Heat treatment process **(Any 6)**	1*6 = 6
SECTION - 5			
9	**a**	Purpose of Heat treatment **(Any 8)**	1*8=8
	b	Differences between Annealing and Normalizing **(Any 4)**	2*4 = 8
	c	Suggestion of heat treatment process + justification	2+2 = 4
10	**a**	Listing of any 4 types of Corrosion	1*4 = 4
	b	Differences between Electrolyte and Non-electrolyte **(Any 3)**	2*3 = 6
	c	Sketch + Explanation	5+5 = 10

I SEM DIPLOMA EXAMINATION, AUGUST / SEPTEMBER 2022

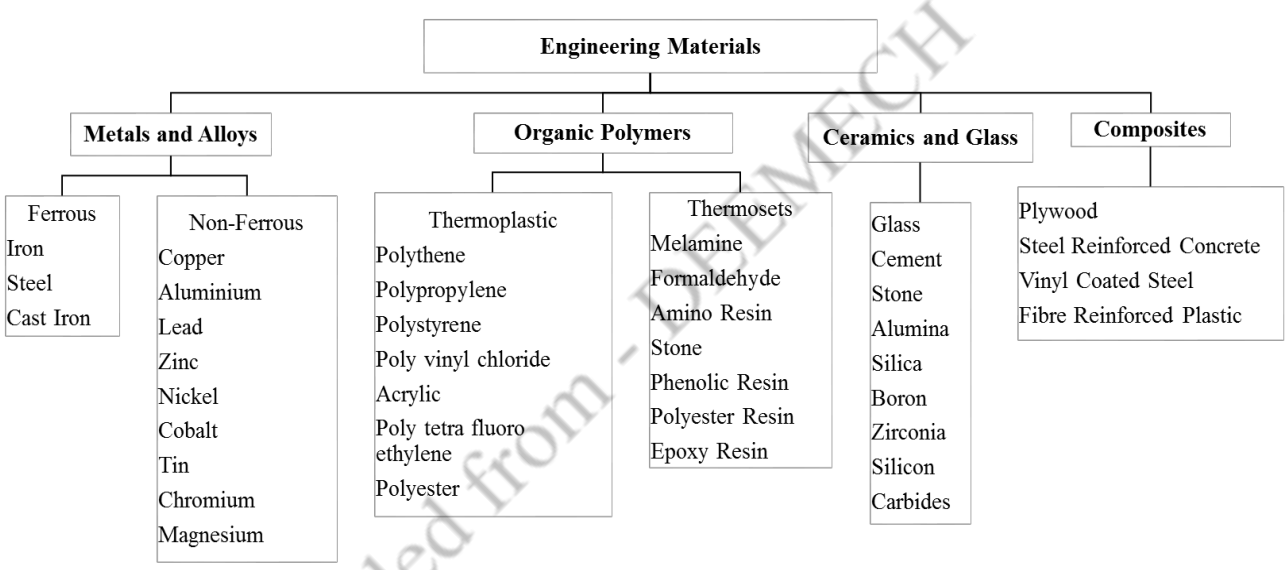
MATERIALS FOR ENGINEERING (20ME11T)

MODEL ANWERS

SECTION - 1

1. a) Classify Engineering materials with examples. (4+4=8 marks)

According to their nature, Engineering Materials are classified as follows:



1. b) List any six mechanical properties of metals. (Any 6) (1*6=6 marks)

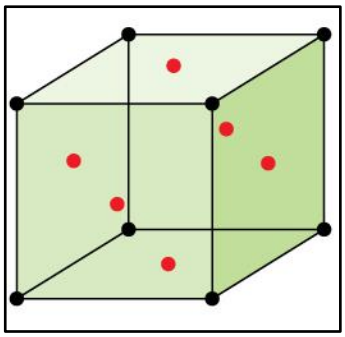
The Mechanical properties of metals are given below;

1. Elasticity
2. Plasticity
3. Ductility
4. Malleability
5. Brittleness
6. Hardness
7. Toughness
8. Stiffness
9. Resilience
10. Creep
11. Endurance
12. Strength

1.c) Sketch and explain FCC crystal structure. (3+3=6 marks)

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 neighboring unit cells.



FCC crystal

This type of unit cell is found in metals like **γ-iron (910^0 C to 1440^0 C), Copper, Silver, Gold, Aluminium, Nickel, Lead and Platinum, etc.**

2. a) Explain Ferrous and Non-ferrous metals with examples. (2+2=4 marks)

Ferrous Metals: Ferrous metals are those metals which are **rich in iron**. Ferrous metals are magnetic and capable of little resistance to the corrosion.

Examples: Wrought Iron, Cast Iron etc.

Non-Ferrous Metals: Non-Ferrous metals are those metals which **do not contain iron as their composition** is called as non-ferrous metals. Lightweight, high conductivity, corrosion resistance and non-magnetic properties are the specialities of the non-Ferrous metals.

Examples: Aluminium, Copper, Lead, Nickel, Tin, Titanium, Zinc etc.

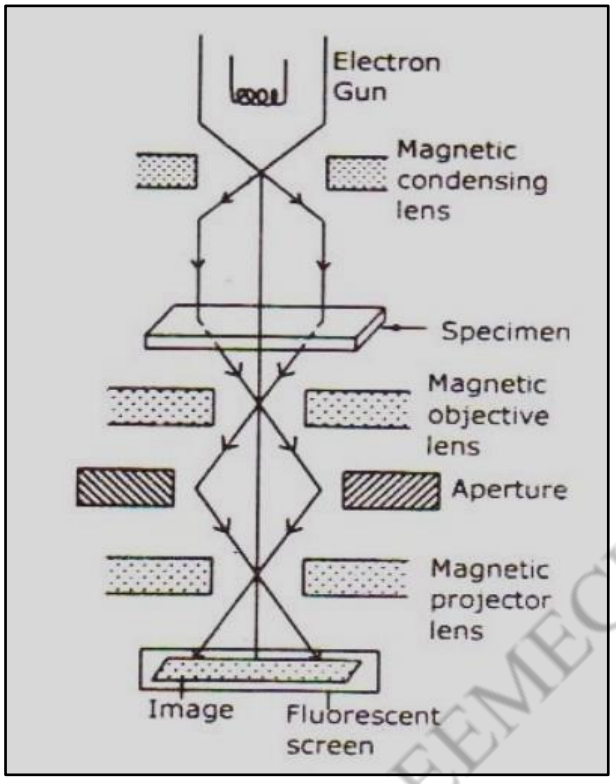
2. b) Sketch and explain Transmission Electron Microscope. (4+4 = 8 marks)

A Transmission electron microscope (TEM) is a type of electron microscope which is used to produce images of a metallographic sample. These Images are later studied and analysed to interpret the topography, crystallographic structure, and composition of the specimen.

The TEM operates on the same basic principles as the light microscope but uses electrons instead of light.

TEM basically consists of:

- An electron gun
- Condenser lens
- Objective lens
- Fluorescent screen or Viewing screen



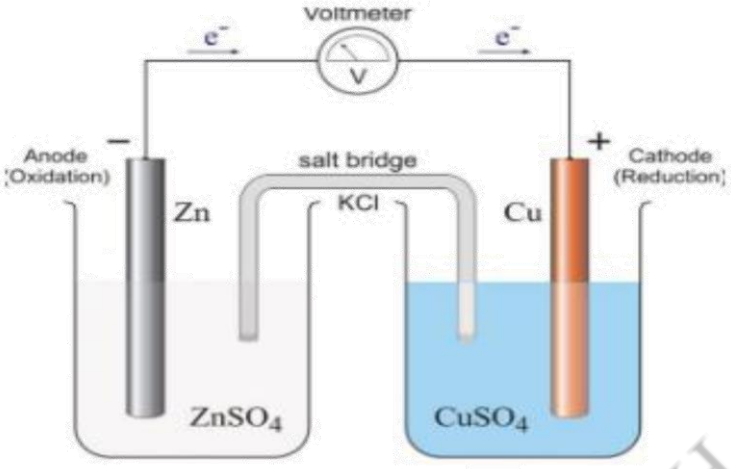
Transmission Electron Microscope

Stream of electrons are produced by an electron gun and is made to fall over the specimen using the magnetic condensing lens. The specimen is placed between the condensing lens and the objective lens as shown in the figure.

Magnetic condensing lens is used to condense the electrons and to adjust the size of the electron that falls on to the specimen. Based on the angle of incidence, the beam is partially transmitted and partially diffracted through the specimen. In order to obtain a high intensity and high contrast image of the specimen, it is essential to eliminate the diffracted electron beam. This is achieved by passing the resultant beam through magnetic objective lens and the aperture.

Thus, transmitted beam alone is made to pass through the projector lens for further magnification. The magnified image is recorded in fluorescent (Phosphor) screen. This high contrast image is called Bright Field Image, which gives the required information like surface topography, crystallographic structure, and composition of the specimen.

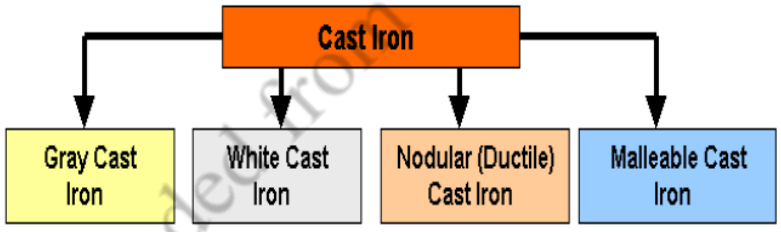
2. c) Sketch and label the parts of an Electro-chemical cell. (4+4=8 marks)



Electro-chemical cell

SECTION - 2

3. a) List the different types of Cast Iron. (1*4=4 marks)



3. b) Mention the type of metal used for making following components and justify your answer. (i) Agricultural equipments (ii) Antifriction bearings (4+4=8 marks)

(i) Agricultural equipments: Low carbon steel is used extensively in the making of Agricultural equipments.

Low carbon steel has following desirable properties for making Agricultural equipments;

- They possess good machinability.
- They possess excellent weldability.
- They have outstanding ductility.
- They have outstanding toughness.
- Most abundant grade of steel
- Least expensive.

(ii) Antifriction bearings: **Chromium steel** (1% carbon, 0.3% manganese, 1.5% chromium remainder substantially iron) is used to make Antifriction bearings.

Chromium steel has following desirable properties for making Antifriction bearings;

- Hard, clean and wear resistant.
- It can functions at temperatures up to 120°C, upon heat treatment can work at 220°C.

3.c) Indicate the meaning of following designations. (2*4=8 marks)

(i) Fe250 (ii) 55C4 (iii) FeE300 (iv) BM300

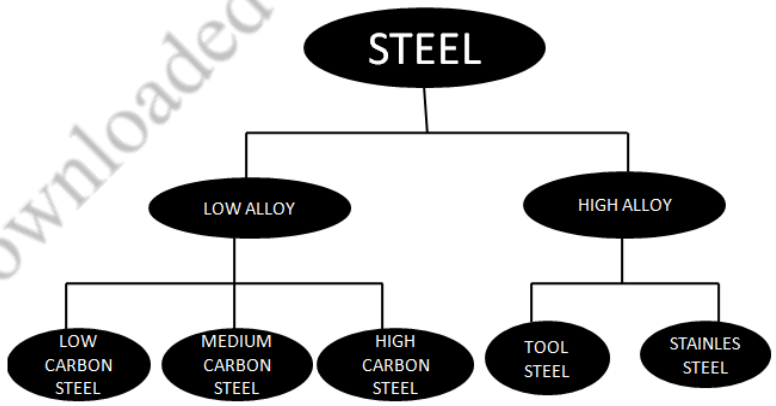
(i) Fe250 : Steel with a Tensile strength of 250 N/mm^2

(ii) 55C4 : Plain carbon steel with 0.55% Carbon and 0.04 % Manganese

(iii) FeE300 : Steel with Yield strength of 300 N/mm^2

(iv) BM300 : Blackheart Malleable Cast iron with a 300 N/mm^2 minimum tensile strength

4. a) Write the classification of Steel. (6 marks)



4. b) State the purpose of alloying? (Any 6) (1*6=6 marks)

The purpose of alloying steel is,

1. To improve hardness
2. To improve Strength
3. To improve toughness

4. To improve corrosion resistance
5. To improve wear resistance
6. To improve machinability
7. To improve high or low temperature stability
8. To control grain size
9. To improve ductility

4. c) Mention the type of Stainless steel with its properties for following applications

(i) Food processing (ii) Surgical and dental instruments (4+4=8 marks)

Application	Type of Stainless steel	Properties
(i) House hold utensils	Ferritic Stainless Steels	Good Cold-Formability, Good resistance to corrosion, Magnetic and non-hardenable, Low carbon content
(ii) Surgical and dental instruments	Martensitic Stainless Steels	Very hard and possess strain-resisting properties, magnetic, poor weldability

SECTION - 3

5. a) Differentiate between Brass and Bronze. (1*6=6 marks)

Sl. No.	Brass	Bronze
1	It is an alloy of copper and zinc	It is an alloy of copper and tin
2	Composition: 55 to 95% Copper 5 to 45% Zinc	Composition: 75 to 95% Copper Up to 12% Tin
3	It is golden yellowish in colour	It is reddish brown in colour
4	It has high malleability	It has high ductility
5	It is not ferromagnetic	It is non-magnetic
6	It is used in making musical instruments, Costume jewellary, fashion jewellary, etc	It is used in making sculpture, Bearings, bells, electrical connectors and springs
7	It possesses good mechanical properties and corrosion resistance.	It possesses superior mechanical properties and corrosion resistance to brass.

5. b) State any three (3) properties and two (2) uses of following metals (i) Copper (ii) Aluminium (5+5=10 marks)

(i) Copper:

Properties: (any 3)

- High Thermal Conductivity
- High Electrical Conductivity
- Good Corrosion Resistance
- High Ductility
- Melting point is 1084^0C
- Boiling point of copper is 2562^0C
- Specific gravity of Copper id 8.9.
- The tensile strength of copper varies from 150MPa to 400MPa under different conditions.
- Good Malleable properties because of FCC Structure
- Addition of tellurium to copper results in increased machinability.

Uses: (any 2)

- Copper is used in **electrical conductor, Electrical wires, Electrical tubes etc**
- It is used in **Kitchen appliances, automotive radiators, Heat exchangers, heating vessels** etc.
- It is used for providing **coating on steel prior to nickel and chromium plating.**
- It is largely used in **electroplating.**
- It is widely used for **making coins**.

(ii) Aluminium

Properties: (any 3)

(1) Aluminium is a light metal & easily machinable

(2) It has good surface finish

(3) Good electrical and thermal conductivities

(4) Highly reflective to heat and light

(5) Versatile metal

(6) Aluminium can be riveted, welded, brazed, or resin bonded.

(7) Corrosion resistant

(8) Aluminium and its alloys provide high strength-to-weight ratio (high specific strength) due to low density.

(9) High Ductility: Aluminium is ductile and has a

(10) Low melting point and density.

(11) Melting point of aluminium is 658^0C.

(12) The tensile strength of the metal varies from 90 MPa to 150 MPa.

(13) Boiling point of aluminium is 2057^0C.

Uses: (any 2)

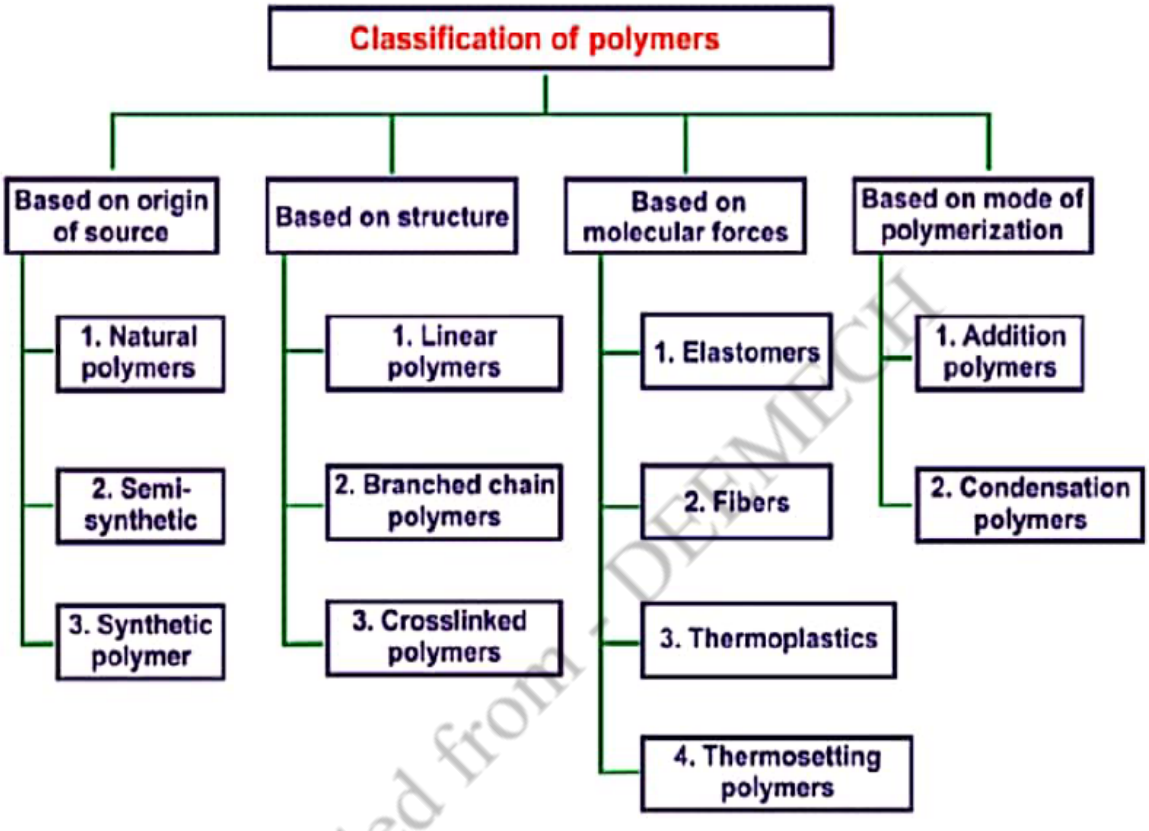
- Aluminium is used in **Computer Motherboards and LED Lights, Overhead Cable etc**.
- **Light Fittings or Rescue Blankets**.
- **Cool roofs** made of coated aluminium
- It is used to produce **Sheets, Foil, Geometrical Configurations, Tubes, Rods or Wires etc**.
- **Aerospace and Automotive** Applications.
- **Cooking Utensils and Thin Foils** for wrapping food items.

5.c) Explain Self-lubrication bearings. (4 marks)

- Self-lubricating bearings provide their own lubrication during operation without requiring application of grease or oil lubricants**.**
- These bearing have following properties
    - High load capacity,
    - Impact resistance,
    - High temperature withstand,
    - Self-lubricating ability and other characteristics, especially for heavy load and low speed.
- These are widely used in metallurgical continuous Casting Machine, Rolling Equipment, Mining Machinery, Moulds, Lifting Machinery, Textile Machinery, Wind Power Generation, Ships, Steam Turbines, Turbines, Injection Moulding Machines and Equipment Production Lines.

- Bronze, Lead, Copper & Aluminium alloys And Sintered Iron & Copper etc are the common materials used for making self-lubricating bearings.

6. a) Give classification of Polymers. (4+6=10 marks)



6. b) List any five properties of Ceramics. (1*5=5 marks)

Following are the properties of Ceramics;

1. It has high hardness.
2. It has high brittleness
3. It has high melting point
4. It has high compressive strength
5. It has good corrosion resistance
6. It is a bad conductor of electricity
7. It has low thermal conductivity

6. c) Explain the designation of Plastics. (5 marks)

"1" signifies that the product is made out of polyethylene terephthalate (PET) (Beverage bottles, cups, other packaging, etc.)

"2" signifies high-density polyethylene (HDPE) (bottles, cups, milk jugs, etc.)

"3" signifies polyvinyl chloride (PVC) (pipes, siding, flooring, etc.)

"4" signifies low-density polyethylene (LDPE) (plastic bags, six-pack rings, tubing, etc.)

"5" signifies polypropylene (PP) (auto parts, industrial fibers, food containers, etc.)

"6" signifies polystyrene (PS) (plastic utensils, Styrofoam, cafeteria trays, etc.)

"7" signifies other plastics, such as acrylic, nylon, polycarbonate and poly lactic acid (PLA).

SECTION - 4

7. a) List any four applications of Smart material. (1*4=4 marks)

Following are the application of smart materials;

1. Aerospace
2. Mass transit
3. Marine
4. Automotive
5. Computers and other electronic devices
6. Consumer goods applications
7. Civil engineering
8. Medical equipment applications
9. Rotating machinery applications

7. b) Differentiate between Thermosetting and Thermoplastic materials.

(2*5=10 marks)

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 molding operation.	They undergo chemical change in the molding 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.

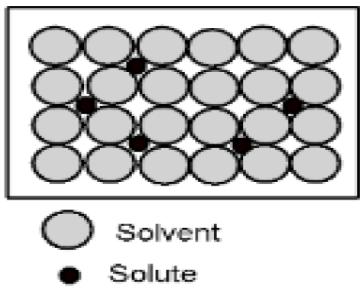
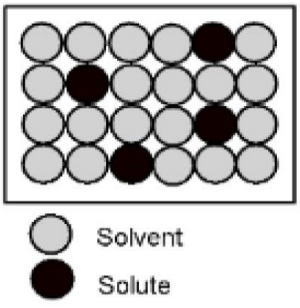
7. c) Suggest an advanced material for Medical application. Justify your answer. (3+3=6 marks)

Biomaterials are suggested for Medical applications.

Biomaterials have following properties which are suitable for Medical applications;

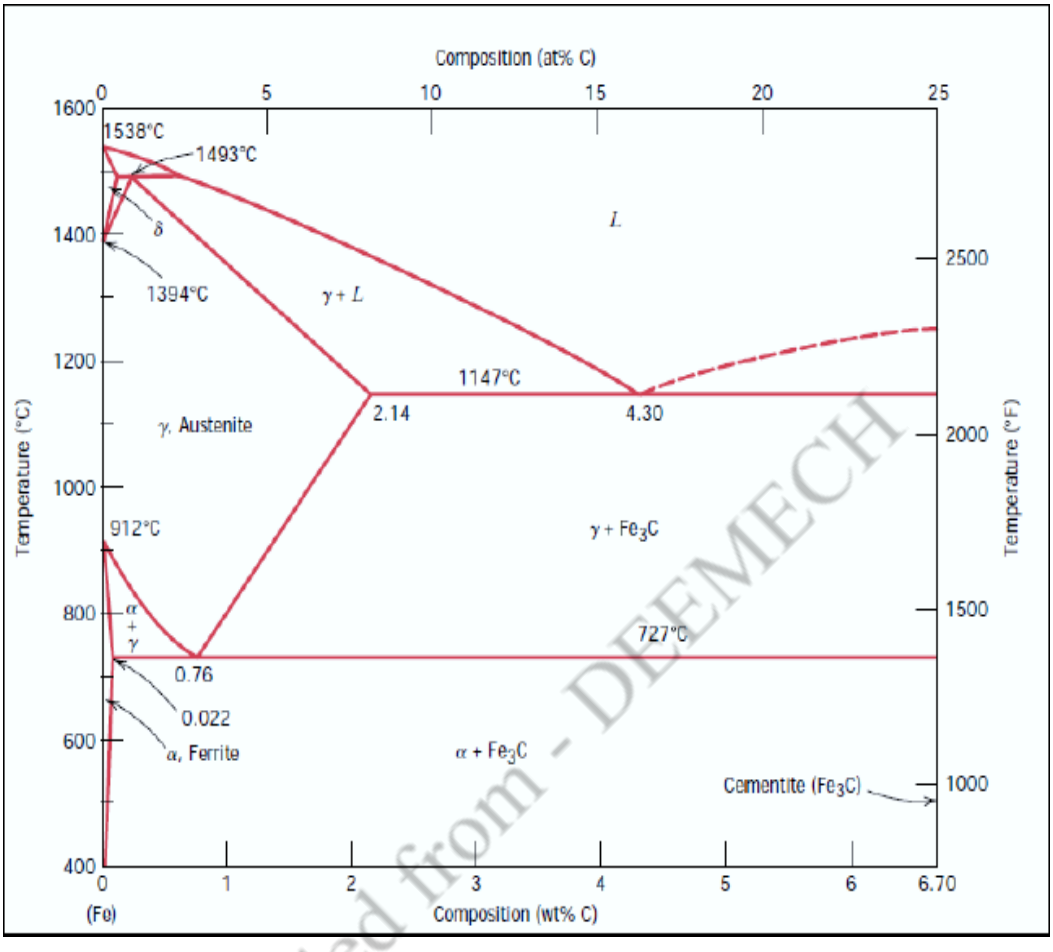
1. They do not react with any tissue in the body.
2. They are non-toxic to the body.
3. Long term replacement won't be biodegradable.

8. a) Distinguish between Interstitial and Substitutional solid solution. (2*2=4 marks)

Sl. No.	Interstitial solid solution	Substitutional solid solution
1	Interstitial solid solutions are formed when the solute atoms found in the holes or interstices between the solvent atoms.	Substitutional solid solutions are formed when the solute metal atoms substitute the solvent atoms in a crystal structure.
2	The solute atoms are very small in comparison with the solvent (matrix) atoms.	The solvent metal atoms and solute metal atoms are of same size.
3		

8. b) Draw Iron-Carbon Equilibrium diagram indicating various phases.

(5+5=10 marks)



Iron-Carbon Equilibrium diagram

8. c) List the different types of Heat treatment process. (Any 6) (1*6=6)

Following 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. (1*8=8 marks)

Following are the purpose of Heat Treatment;

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 etc
7. To improve electrical and magnetic properties
8. To increase the resistance to wear, tear, heat and corrosion
9. To removes trapped gases, etc

9. b) Differentiate between Annealing and Normalizing. (Any 4)

(2*4=8 marks)

Sl. No.	Annealing	Normalizing
1	It consists of heating of Steel parts to a temperature at or near the critical temperature (900^0C), holds it at that temperature for a suitable time and then allowed to cool slowly in the Furnace itself.	It consists of heating the Steel 50^0C above its upper critical temperature (810^0C to 930^0C). It is held at this temperature for about 15 minutes and then allowed to cool down in still air.
2	Steel parts are gradually cooled in a Furnace.	Steel parts are gradually cold in still Air.
3	Comparatively lower yield point, ultimate tensile strength and impact Strength.	Comparatively higher yield point, ultimate tensile strength and impact Strength.
4	Comparatively soft and easily Machinable.	Comparatively lesser soft
5	Low hardness	Relatively harder
6	Highly ductile and percentage of elongation is more	Less ductile and relatively percentage of elongation is less

9. c) Suggest a suitable heat treatment process during manufacturing of Coils & Laminated springs. Justify the answer. (2+2=4 marks)

Medium Temperature Tempering (heating to 250℃ to 350℃) is suitable during the manufacturing of Coils & Laminated springs.

Medium Temperature Tempering **provides the highest elastic limit with ample toughness**.

10.a) List different types of Corrosion. (Any 4) (1*4=4 marks)

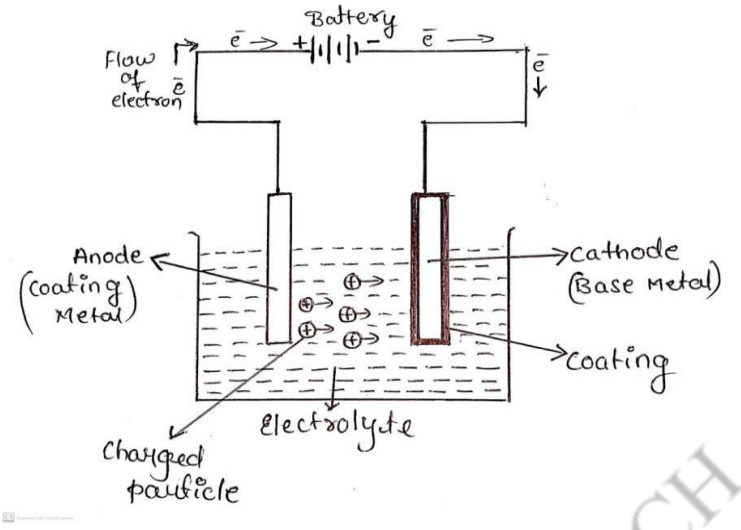
Following are the different types of Corrosion;

1. Dry or chemical corrosion
2. Wet or Electrochemical corrosion
3. Galvanic corrosion
4. Uniform corrosion
5. Pitting corrosion
6. Intergranular corrosion
7. Stress corrosion
8. Crevice corrosion
9. Atmospheric corrosion
10. Selective corrosion
11. Underground corrosion
12. Erosion corrosion

10.b) Differentiate between Electrolyte and Non-electrolyte. (2*3=6 marks)

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

10.c) Explain with a neat sketch Electroplating process. (5+5=10 marks)



Electroplating is a process in which electric current is used to deposit a thin layer of metal coating over a base metal in an electrolyte solution containing dissolved salt of coating metal.

- It consists of battery, electrolyte solution and two electrodes. The two electrodes are base metal electrode and coating metal electrode.
- Both the electrodes are dipped in electrolyte solution in which coating metal electrode act as anode and base metal electrode act as cathode.
- Anode is connected to positive terminal of the battery and cathode is connected to the negative terminal of the battery.
- When the current is passed metal at anode starts dissolving in the solution due to anodic reaction and the dissolved metal starts depositing on the cathode.
- The thickness of coating depends upon the time up to which the current is passed.
- Commonly used metals for coating are copper, nickel, silver, gold etc.