3473 **Code : 20ME11T**

Register Number | | | | | | | | | | |

I Semester Diploma Examination, April/May-2021

MATERIALS FOR ENGINEERING

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

Instruction : Answer **one** full question from each Section. One full question carries **20** marks.

SECTION – I

1. (a) Classify engineering materials with examples. **10**
   (b) Explain BCC and FCC structures. **10**

2. (a) State the reasons for the rust in metals. **10**
   (b) Differentiate between Electrochemical Series and Galvanic Series. (Any Five) **10**

SECTION – II

3. (a) Explain how Cast Iron is produced. State any five applications of it. **10**
   (b) Explain cast iron which has white fracture ? State any four applications of it. **10**

4. (a) Define Alloy Steel. What are the effects of alloying elements on properties of alloy steel ? **10**
   (b) Define stainless steel. List it types and explain any one. **10**

SECTION – III

5. (a) State any five differences between Ferrous and Non-Ferrous metals. **10**
   (b) Describe the composition and application of copper tin alloy which has 94.16% copper. **10**

6. (a) Write the properties of bearing materials. **10**
   (b) Explain working of an Electro Chemical Cell. **10**

SECTION – IV

7. (a) List any five differences between Metals and Non-Metals. **10**

(b) Write the thermoset type for the below mentioned uses : **10**

(i) Brackets

(ii) Casting compounds

(iii) Relays

(iv) Sealants

(v) Knobs and handles

8. (a) Distinguish between thermoplastics and thermosetting plastics. **10**

(b) Define Ceramics. List its types and state any four applications of it. **10**

SECTION – V

9. (a) Sketch and label Iron carbon phase diagram. **10**

(b) Write any five purposes of heat treatment process. **10**

10. (a) List any five properties of Normalizing process. **10**

(b) Explain the process in which carbon is added to the surface of low carbon steel. **10**

I Semester Diploma Examination AUGUST 2021

Mechanical Engineering Programme

Sub Name: **Materials for Engineering** Sub Code: **20ME11T** Max Marks: **100**

SCHEME ANSWERS RUBRICS

SECTION - I				
Q. NO.	**Question Description**	**RUBRICS**		**Max Marks**
1. (a)	**Classify engineering materials with examples.**	Main Classification	Two examples to each Main Classification	4+6 = **10**
		4*1= **4**	8 *1.3 = **6**	
(b)	**Explain BCC and FCC Structures.**	Figures of BCC and FCC	Explanation of BCC and FCC	4+6 = **10**
		2+2= **4**	3+3 = **6**	
2. (a)	**State the reasons for the Rust in Metals?**	Identification of Rust as CORROSION	Written any Six Reasons of Corrosion	4+6 = **10**
		4	6 * 1 = **6**	
(b)	**Differentiate between Electrochemical series and Galvanic series (Any Five)**	Written any Five Differences		**10**
		5 * 2= **10**		
SECTION - II				
3. (a)	**Explain how cast Iron is produced? State any five applications of it**	How CI is Produced	Written any five applications of CI	5+5 = **10**
		5	5*1 = **5**	
(b)	**Explain cast iron which has white fracture? state any four applications of it**	Identification of White fracture as White Cast Iron + Explaining It	Written any Four applications	6+4 = **10**
		3+3= **6**	4 * 1 = **4**	
4. (a)	**Define alloy Steel? what are the effects of alloying elements on properties of alloy Steel**	Definition	Written any Eight effects	2+8 = **10**
		2	8 * 1 = **8**	
(b)	**Define stainless steel? list it types and explain any one**	Definition + Types	Explain Any one	5+5 = **10**
		2+3 = **5**	**5**	
SECTION - III				
5. (a)	**State any five differences between ferrous and nonferrous metals**	Written any Five Differences		**10**
		5 * 2= **10**		
(b)	**Describe the composition and application of copper tin alloy which has 94.16% copper**	Identification of 94.16 Copper as Phosphor Bronze	Composition + Applications	5+5 = **10**
		5	2 + 3= **5**	
6. (a)	**Write the properties of bearing metals**	Written any Five properties		**10**
		5 * 2= **10**		
(b)	**Explain working of an electrochemical cell**	Figure	Chemical Equation + Explanation	5+5 = **10**
		5	2 + 3 **= 5**	

SECTION - IV				
7. (a)	**List any five differences between Metals and Non Metals.**	Written any Five Differences		**10**
		5 * 2= **10**		
(b)	**Write the thermoset type for the below mentioned uses: (i) Brackets (ii) Casting Compounds (iii) Relays (iv) Sealants (v) Knobs & Handles**	Identification of Thermoset Types		**10**
		5 * 2 = **10**		
8. (a)	**Distinguish between thermoplastics and thermosetting plastics**	Written any Five Differences		**10**
		5 * 2= **10**		
(b)	**Define ceramics? list types and state any four applications of it**	Definition + Types(any 4)	Written any Four applications	6 + 4 = **10**
		2+ (4*1) = **6**	4*1 = **4**	
SECTION - V				
9. (a)	**Sketch and label Iron Carbon phase diagram**	Sketch	Label	5+5 = **10**
		5	**5**	
(b)	**Write any five purpose of heat treatment process**	Written any Five purposes		**10**
		5 * 2= **10**		
10. (a)	**list any five properties of Normalising process.**	Written any Five properties		**10**
		5 * 2= **10**		
(b)	**Explain the process in which carbon is added to the surface of low Carbon Steel**	Identification of process as Carbuzising	Explaining the process	4 + 6 = **10**
		4	**6**	

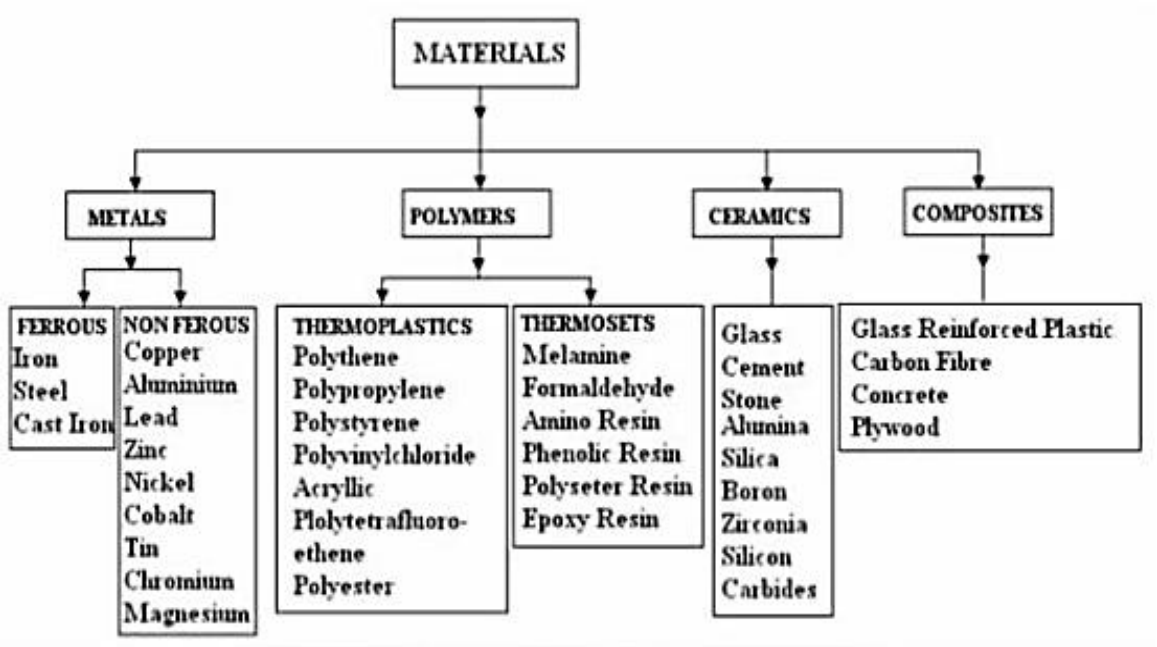
I Semester Diploma Examination AUGUST 2021
SCHEME ANSWERS

Sub Name: **Materials for Engineering**
Sub Code: **20ME11T** Max Marks: **100**

Instruction: Answer **ONE** full question from each Section. One full question carries **20** Marks

SECTION – I

1. (a) Classify engineering materials with examples. -- 10 Marks



(b) Explain BCC and FCC Structures. -- 10 Marks

Body centered cubic (BCC): It is a Centered cube with 9 atoms of which 8 are located at the corners of the cube and the 9th at the centre. This type of lattice is found in the following metals barium, chromium, columbium, iron, molybdenum, tungsten, vanadium.

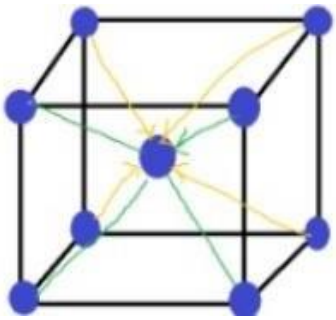


Fig: BCC

Face centered cubic (FCC): It has 14 atoms of which 8 are located at the corners of the cube and 6 at the centers of the six faces. This lattice has a more compact packing of the atoms than the preceding one. This type is typical of the metals are aluminum, Copper, Gold, lead, nickel, Platinum, silver.

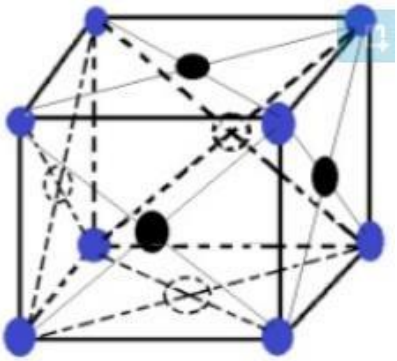


Fig: FCC

2. (a) State the reasons for the Rust in Metals? --10 Marks

Reasons for corrosion/ Rust

The following are the reasons for corrosion

1. Exposure of the metals to air containing gases like CO2, SO2, SO3 etc.

2. Exposure of metals to moisture especially salt water (which increases the rate of corrosion).

3. Presence of impurities like salt (e.g. Na Cl).

4. Stability of the corrosion products.

5. Biological organisms (particularly anaerobic bacteria).

6. Variation in composition of the corrosive medium.

7. Temperature: An increase in temperature increases corrosion.

8. Nature of the first layer of oxide formed: some oxides like Al2O3 forms an insoluble protecting layer which can prevent further corrosion. Others like rust easily crumble and expose the rest of the metal.

9. Acids present in Atmosphere can easily accelerate the process of corrosion

(b) Differentiate between Electrochemical series and Galvanic series (Any Five) -10 Marks

Electrochemical series

1. Electrode potentials are measured by dipping pure metals in their salt solution of IM concentration, without any oxide films on them.

2. The position of a metal in electrochemical series is fixed.

3. It gives no information regarding the positions of alloys.

4. The position of metal is permanently fixed in this series.

5. This series comprises of metals and non-metals.

6. It predicts the relative displacement tendencies.

7. It is absolute.

8. It is quantitative.

9. it is a series only for pure metals.

10. It is used for theoretical calculations.

Galvanic series

1. This series was developed by studying corrosion of metals and alloys in unpolluted sea-water, without their oxide films, if any removed.

2. In galvanic series, the position of a given metal may shift.

3. Their corrosion can be studied from this series since alloys are included in galvanic series

4. The position of metal, when present in the form of an alloy, is different from that of pure metal.

5. This series comprises of metals and alloys.

6. It predicts the relative corrosion tendencies.

7. It is relative.

8. It is qualitative.

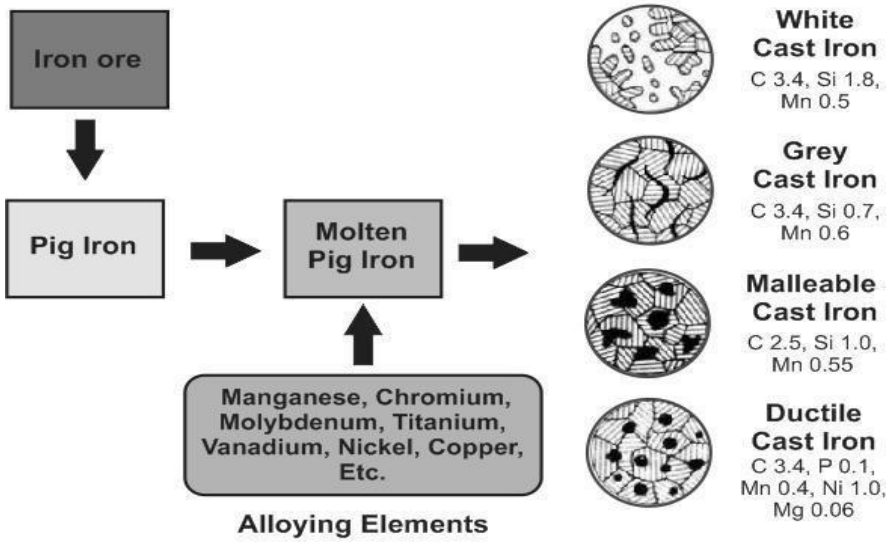
9. It is a series for pure metals and alloys also.

10. It is used for practical applications.

SECTION – II

3. (a) Explain how cast Iron is produced? State any five applications of it -10 Marks

How Cast Iron is produced:



Cast iron (CI) is produced from the pig iron. And pig iron is produced by melting iron ore in a blast furnace. The pig iron is converted into ingots and then these ingots are re-melted again to produce cast iron. CI can also be produced directly from the molten pig iron.

Applications of Cast Iron:

- Machine tool structures (bed, frame, etc).
- Gas or water pipes for underground purposes.
- Manhole covers.
- Cylinder blocks and heads for I.C. Engines.
- Frames for electric motors.
- Piston rings, household applications.
- It is used in the manufacture of wrought iron and malleable cast iron.
- Used for outer surface of car wheels.
- Rolls for crushing grains and jaw crusher plates.
- Lifter bars and shell liners in grinding mills, wear surfaces of pumps, balls and rings of coal pulverisers, etc.
- Conveyor chain links.
- Hubs of wagon wheels, small fittings for railway rolling stock, brake supports
- Gear case.
- Electrical line hardware.
- Automotive crankshaft.

- Crankshaft sprocket.
- It is widely used in cast parts where density and pressure tightness is a highly desirable quality.
- They include hydraulic cylinders, valves, pipes and pipe fittings, cylinder head etc.
- Widely used in paper industries machinery.
- For making power transmission equipment.
- For making earth moving machinery.
- For making pumps and compressors

(b) Explain cast iron which has white fracture? state any four applications of it -10 Marks

The **White cast iron shows a white fracture** and has the following approximate **compositions:** Carbon = 1.75 to 2.3%; Silicon = 0.85 to 1.2%; Manganese = less than 0.4%; Phosphorus = less than 0.2%; Sulphur = less than 0.12%, and the remaining is iron.

The white color is due to fact that it has no graphite and whole of the carbon is in the form of carbide or cementite Fe3C which is the hardest constituent of iron. The presence of carbon in this form, as opposed to graphite, is the result of a lower silicon content compared to grey cast iron.

Applications of White Cast Iron:

- It is used in the manufacture of wrought iron and malleable cast iron.
- Used for outer surface of car wheels.
- Rolls for crushing grains and jaw crusher plates.
- Lifter bars and shell liners in grinding mills
- Wear surfaces of pumps, balls and rings of coal pulverisers, etc.

4. (a) Define alloy Steel? what are the effects of alloying elements on properties of alloy Steel --10 Marks

Alloy Steel: Alloy steel may be defined as steel to which elements other than carbon are added in sufficient amount to produce an improvement in properties.

The various alloying elements affect the properties of steel as follows:

1. **Silicon:** The amount of silicon in the finished steel usually ranges from 0.05 to 0.30 %. Silicon is added in low carbon steels to prevent them from becoming porous. It removes the gases and oxides, prevent blow holes and thereby makes the steel tougher and harder. Higher % of silicon gives rise to corrosion resisting alloys.

2. **Manganese:** It serves as a valuable deoxidizing and purifying agent, in steel. Manganese also combines with sulphur and thereby decreases the harmful effect of

this element remaining in the steel. When used in ordinary low carbon steels, manganese makes the metal ductile and of good bending qualities. In high speed steels, it is used to toughen the metal and to increase its critical temperature. The manganese content of carbon steels commonly ranges from 0.30 to 1.00 %.

3. **Nickel:** It improves toughness, tensile strength, and ductility and corrosion resistance.
4. **Chromium:** It increases strength, hardness, toughness, and corrosion resistance.

5. Cobalt: It improves hardness, toughness, tensile strength, thermal resistance, and magnetic properties.

6. Molybdenum: It increase wear resistance, thermal resistance, hardness ability to retain mechanical properties as elevated temperature. When added with nickel, it improves corrosion resistance.

7. Tungsten: It increases hardness, toughness, wear resistance, shock resistance, magnetic reluctance and ability to retain mechanical properties at elevated temperature.

8. Vanadium: It improves tensile strength, elastic limit, ductility, shock resistance and also acts as a degasser when added to molten steel. It is added in low and medium carbon steels in order to increase their yield tensile strength properties.

9. Boron: It increase hardenability and is therefore, very useful when alloyed with low carbon steels.

10. Aluminium: It is basically used as a deoxidiser. It improves the growth of fine grains and helps in providing a high degree of hardness through nitriding by forming aluminium nitrides.

11. Titanium: It is fairly good deoxidiser and promotes grain growth. Also, forms titanium carbides but has no marked effect on the hardenability of the material.

12. Copper: It increases the strength and improves resistance to corrosion. Its proportion normally varies from 0.2% to 0.5%.

13. Niobium: It improves ductility, decrease hardenability and substantially increases the impact strength

(b) Define stainless steel? list it types and explain any one --10 Marks

Stainless steels are steels containing at least 10.5% chromium, less than 1.2% carbon and other alloying elements.

Stainless steels are classified according to the basis of their structures are;

- Austenitic Stainless steel
- Ferritic Stainless steel
- Martensitic Stainless Steel

Austenitic stainless steel: Austenitic stainless steel contains a minimum of 16% chromium and 6% nickel. They range from basic grades like 304 through to super austenitics such as 904L and 6% Molybdenum grades.

Applications for austenitic stainless steel include:

- Kitchen sinks
- Architectural applications such as roofing and cladding
- Roofing and gutters, Doors and Windows
- Benches and food preparation areas, Food processing equipment
- Heat exchangers, Ovens & Chemical tanks

Ferritic Stainless steels: Ferritic Stainless steels will usually only have chromium as an alloying element. The chromium content ranges from 10.5 to 18%. They have average corrosion resistance and poor fabrication characteristics. Heat treatment methods do not help with hardening the metal either. They generally have better engineering abilities than austenitic grades. Unlike austenitic grades, they are magnetic. They also have good resistance to stress corrosion, resulting in lower corrosive material wear. Ferritic stainless steel are typically used in:

- Vehicle exhausts, Fuel lines, Cooking utensils
- Architectural trim & Domestic appliances

Martensitic Stainless steel: This type of stainless steel consists of high carbon and lower chromium content. Like ferritic grades, it is magnetic. It does display poor weldability compared to other grades but it has higher hardenability and can be heat treated to improve properties. Martensitic stainless steel will have lower corrosion resistance when compared with austenitic and ferritic grades with the same chromium and alloy content. Martensitic Stainless steel are used to make

- Knife blades
- Cutlery
- Surgical instruments
- Fasteners, Shafts & Spring

SECTION - III

5.(a) State any five differences between ferrous and nonferrous metals

--10Marks

	Ferrous Metals	Ferrous Metals (NON)
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	The usage of ferrous metals ushered in the iron age.	Non-ferrous metals are ushered in the bronze age.
7	Some ferrous metals are- vehicle scrap metal, demolition site scrap metal, metal off cuts from manufacturing industries.	Some non-ferrous metals are-aluminum and aluminum alloys, copper, brass, lead, zinc, stainless steel, electronic cable etc
8	Ferrous metals are used - cutlery, kitchen equipment, ball bearings etc.	Non-ferrous metals are used- water pipes, electrical wire, decorative goods, soft solder etc.
9	Ferrous metal includes mild steel, carbon steel, stainless steel, cast iron and wrought iron.	Non-ferrous metals are used where their difference from ferrous metals can provide an advantage.
10	Ferrous metals make up the most recycled materials in the world	As per the recycling goes, many non-ferrous materials are relatively scarce.
11	Ferrous scrap metals tend to be in good supply.	Non-ferrous scraps are harder to come by.
12	The price of ferrous metal tends to be lower.	Prices of non-ferrous metals are greater than ferrous metals

(b) Describe the composition and application of copper tin alloy which has 94.16% copper **--10 Marks**

Copper Tin Alloy: Phosphor Bronze

Composition % : Cu = 94.16 , Sn 5.56 P=0.24

Properties and Uses: Phosphor increases the strength, ductility and good casting properties. The alloy possesses good wearing resistant quality and high elasticity. The metal is resistant to salt water corrosion.

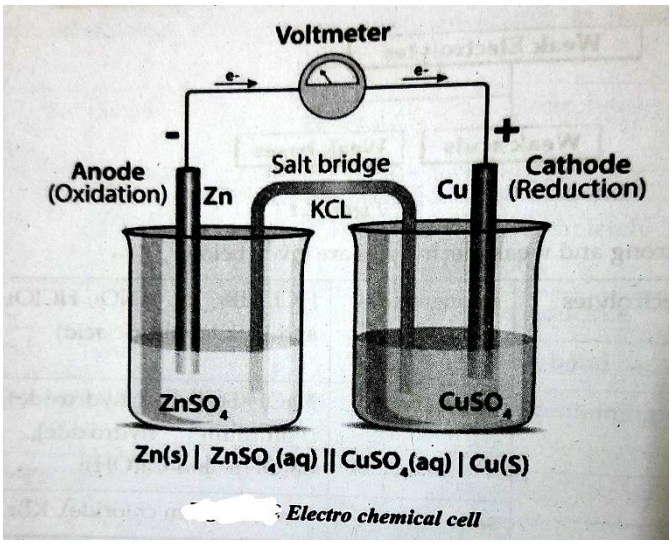
It is used for bearing; pump parts, linings and propellers. Also used for worm wheels, gears, nuts for machine lead screws, springs.

6. (a) Write the properties of bearing metals **--10 Marks**

A bearing material should have the following properties:

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

(b) Explain working of an electrochemical cell **--10Marks**



Electro chemical cell

Working of an Electrochemical Cell

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

$Zn(Solid) + CuSO_4(Aqueous) \longrightarrow ZnSO_4(Aqueous) + Cu\ (Solid)$

The ionic form of the reaction is: Zn + Cu2+ Zn2+ + Cu

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

1. Oxidation half reaction: $Zn \longrightarrow Zn^{2+} + 2e^-$

2. Reduction half reaction: $Cu^{2+} + 2e^- \longrightarrow Cu$

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.

SECTION - IV

7 (a) List any five differences between Metals and Non Metals. –10 Marks

Difference between Metals and Non Metals

Sl. No.	Property	Metals	Non-Metals
1.	Structure	All metals are having crystalline structure	All Non-metals are having amorphic & mesomorphic structure
2.	State	Generally metals are solid at normal temperature	State varies material to material. Some are gas state and some are in solid state at normal temperature.
3.	Valance electrons and conductivity	Valance electrons are free to move within metals which makes them good conductor of heat & electricity	Valence electrons are tightly bound with nucleus which is not free to move. This makes them bad conductor of heat & electricity
4.	Density	High density	Low density
5.	Strength	High strength	Low strength
6.	Hardness	Generally hard	Hardness is generally varies
7.	Malleability	Malleable	Non malleable
8.	Ductility	Ductile	Non ductile
9.	Brittleness	Generally non brittle in nature	Brittleness varies material to material
10.	Luster	Metals possess metallic luster	Generally do not possess metallic lustre (Except graphite & iodine)

(b) Write the thermoset type for the below mentioned uses: --10 Marks

Q. No	Thermoset Type Used for	Thermoset Type
(i)	Brackets	**Alkyl (Polyester)**
(ii)	Casting Compounds	**Epoxy**
(iii)	Relays	**Phenolic**
(iv)	Sealants	**Polyurethane**
(v)	Knobs & Handles	**Phenolic OR Urea and Melamine Formaldehyde**

8. (a) Distinguish between thermoplastics and thermosetting plastics --10 Marks

Property	Thermoplastics	Thermosetting plastics
Action of heat	They soften on heating and set on cooling every time	They set on heating and cannot be resoftened.
Type of bonding Between adjacent polymer chains	The polymer chains are held together by weak force called Vander Waal's force of attraction.	The polymers chains are linked by strong chemical bonds. (covalent bonds)
Solubility	They are soluble in organic solvents.	They are insoluble in organic solvents.
Expansion due to heating	They expand very much on heating.	Their expansion is only marginal due to heat.
Type of polymerisation	They are formed by addition polymerization	They are formed by condensation polymerization
Type of moulding	They are processed by injection moulding.	They are processed by compression moulding.
Scrap recovery	Scarp can be reused.	Scarp cannot be reused.
Example	Polythene, PVC, Nylon	Bakelite, Plaskon

(b) Define ceramics? list types and state any four applications of it --10 Marks

Ceramic materials are inorganic, non-metallic materials made from compounds of a metal and a non metal.

Types of ceramics: Classification of ceramics based on their specific applications and composition.

Based on their composition, ceramics are classified as:

1. Oxides,
2. Carbides,
3. Nitrides,
4. Sulphides
5. Fluorides, etc.

Based on their application, such as:

1. Glasses
2. Clay products
3. Refractories
4. Abrasives
5. Cements
6. Advanced ceramics

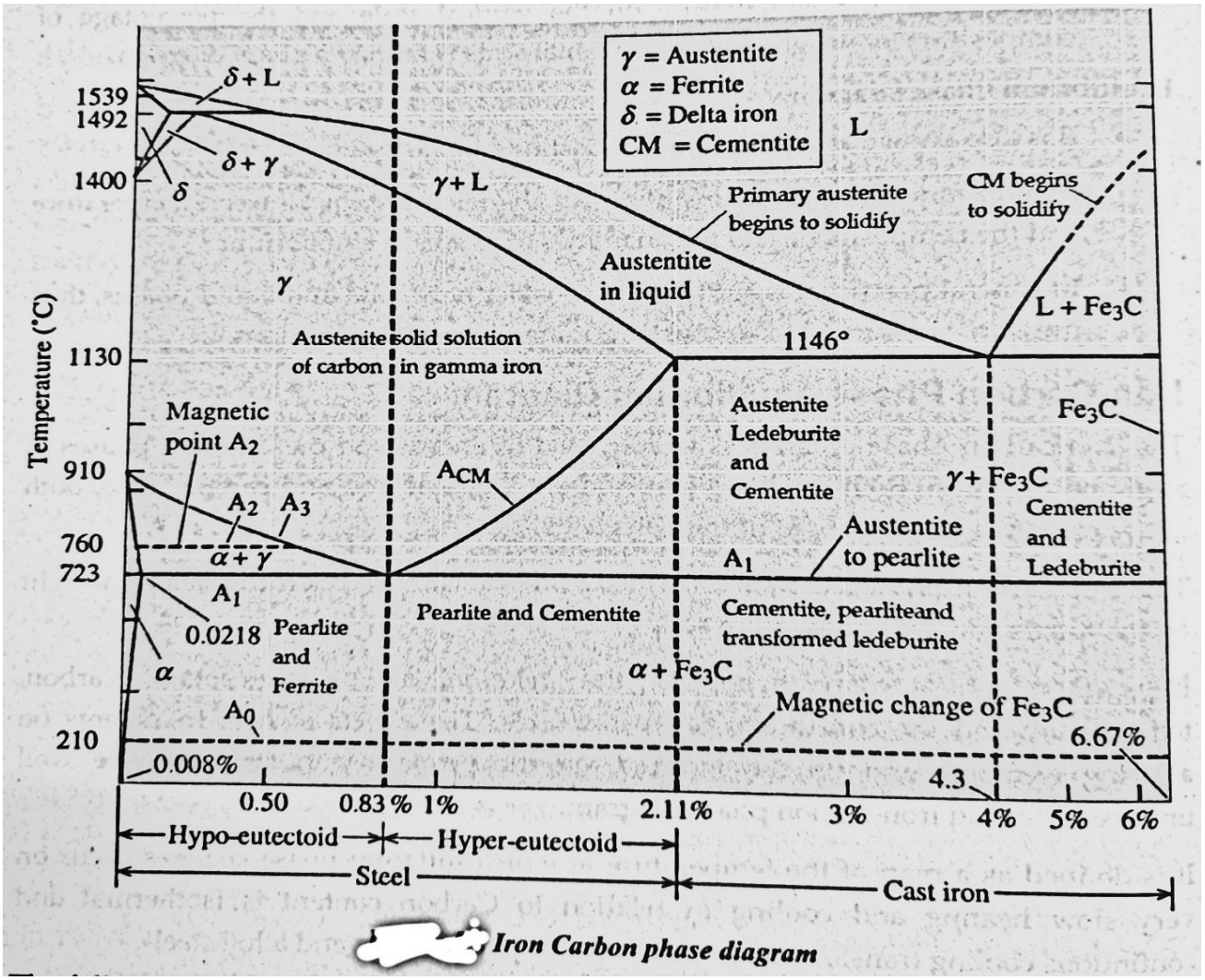
Applications of Ceramics:

Ceramic materials display a wide range of properties which facilitate their use in many different product areas.

1. **Aerospace:** space shuttle tiles, thermal barriers, high temperature glass windows, fuel cells.
2. **Consumer Uses**: glassware, windows, pottery, Corning“ ware, magnets, dinnerware, ceramic tiles, lenses, home electronics, microwave transducers.
3. **Automotive:** catalytic converters, ceramic filters, airbag sensors, ceramic rotors, valves, spark plugs, pressure sensors, thermistors, vibration sensors, oxygen sensors, safety glass windshields, piston rings.
4. **Medical (Bio-ceramics):** orthopedic joint replacement, prosthesis, dental restoration, bone implants.
5. **Military:** structural components for ground, air and naval vehicles, missiles, sensors.
6. **Computers:** insulators, resistors, superconductors, capacitors, ferroelectric components, microelectronic packaging.
7. **Other Industries:** bricks, cement, membranes and filters, lab equipment.
8. **Communications:** fiber optic/laser communications, TV and and radio components, microphones.

SECTION - V

9. (a) Sketch and label Iron Carbon phase diagram **--10 Marks**



Iron Carbon phase diagram

(b) Write any five purpose of heat treatment process **--10 Marks**

1. To relieve internal stresses set up during other operations like casting, welding, hot and cold working, etc.
2. To improve mechanical properties like hardness, toughness, strength, ductility, etc.
3. To improve machinability
4. To change the internal structure to improve their resistance to heat, wear and corrosion.
5. To effect a change in their grain size.
6. To soften them to make suitable for operations like cold rolling and wire drawing.
7. To improve their electrical and magnetic properties.
8. To make their structure homogenous so as to remove coring and segregation.
9. To drive out trapped gases.

10.(a) list any five properties of Normalising process. –10 Marks

1. To refine the grain structure completely. To eliminate coarse grain structure obtained during forging, rolling and stamping.
2. To increase the strength of medium carbon steel.
3. To improve the machinability of low carbon steel.
4. To maintain granular homogeneity and to improve the structure of welds.
5. To reduce internal stresses.
6. To enhance the toughness.
7. To achieve desired results in mechanical and electrical properties.

(b) Explain the process in which carbon is added to the surface of low Carbon Steel --10 Marks

Carburizing is a case-hardening process by which carbon is added to the surface of low-carbon steel. This results in carburized steel that has a high-carbon surface and a low-carbon interior. When the carburized steel is heat-treated, the case becomes hardened and the core remains soft and tough.

In carburizing, the surface hardness of the steel is increased by adding carbon to the component.

1. The steel is heated in contact with a substance that has high carbon content
2. The steel is held at a temperature above the UCT (850 -950°C) for a suitable period of time
3. Then quenched rapidly to produce a hardened surface layer or "case" over a softer and tougher core
4. The steel is then tempered to the desired hardness

References:

- Suggested Learning Resources which are prescribed in the Syllabus
- Materials For Engineering, B.A. Srinivas., Rasha Publications., 2021