UNIT-IV - NON-METALLIC MATERIALS

PART-A

1. **What is polymorphism?**

The ability of a material to exist in more than one crystallographic structure. Numerous metals change in crystallographic structure at transformation temperatures during heating or cooling. If the change is reversible, it is allotropy. The allotropy of iron, particularly the changes between the alpha body-centered and the gamma face centered form, is of fundamental importance in the hardening of steel.

2. **What are the Classification in Polymers**

Polymers are classified in many ways. The prime classification based on their industrial usage is: plastics and elastomers.

3. **What are the Classification in Plastics?**

Based on their temperature dependence of their structure as

- Thermo
- Thermosetting

4. **Define Elastomers**

These polymers are known for their high elongations, which are reversible upon release of applied loads.They consist of coil-like molecular chains, which straighten up on application of load.

E.g.: natural and synthetic rubber.

5. **What is Strengthening polymers**

Polymers' resistance to deformation–strength – is influenced by many parameters.For thermoplastics: average molecular mass, degree of crystallization, presence of side groups,presence of polar and other specific atoms, presence of phenyl rings in main chains and addition of reinforcements.

6. **Define Acrylonitrile-butadiene-styrene (ABS):**

- **Characteristics**: Outstanding strength and toughness, resistance to heat distortion; good electrical properties; flammable and soluble in some organic solvents.
- **Application:** Refrigerator lining, lawn and garden equipment, toys, highway safety devices.

7. **Define Acrylics (poly-methyl-methacrylate)**

- **Characteristics:** Outstanding light transmission and resistance to weathering; only fair mechanical properties.
- **Application:** Lenses, transparent aircraft enclosures, drafting equipment, outdoor signs

8. **Define Fluorocarbons (PTFE or TFE)**

- **Characteristics:** Chemically inert in almost all environments, excellent electrical properties; low coefficient of friction; may be used to 260o C; relatively weak and poor cold-flow properties.
- **Application:** Anticorrosive seals, chemical pipes and valves, bearings, anti adhesive coatings, high temperature electronic parts.

9. Define Polyamides (nylons)

- **Characteristics:** Good mechanical strength, abrasion resistance, and toughness; low coefficient of friction; absorbs water and some other liquids.
- **Application:** Bearings, gears, cams, bushings, handles, and jacketing for wires and cables

10. Define Polycarbonates

- **Characteristics:** Dimensionally stable: low water absorption; transparent; very good impact resistance and ductility.
- **Application:** Safety helmets, lenses light globes, base for photographic film

11. Define Polyethylene

- **Characteristics:** Chemically resistant and electrically insulating; tough and relatively low coefficient of friction; low strength and poor resistance to weathering.
- **Application:** Flexible bottles, toys, tumblers, battery parts, ice trays, film wrapping materials.

12.Define Polypropylene

- **Characteristics:** Resistant to heat distortion; excellent electrical properties and fatigue strength; chemically inert; relatively inexpensive; poor resistance to UV light.
- **Application:** Sterilizable bottles, packaging film, TV cabinets, luggage

12. Define Polystyrene

- **Characteristics:** Excellent electrical properties and optical clarity; good thermal and dimensional stability; relatively inexpensive
- **Application:** Wall tile, battery cases, toys, indoor lighting panels, appliance housings.

13. Define Polyester (PET or PETE)

- **Characteristics:** One of the toughest of plastic films; excellent fatigue and tear strength, and resistance to humidity acids, greases, oils and solvents
- **Application:** Magnetic recording tapes, clothing, automotive tire cords, beverage containers.

14. Differentiate thermosetting and thermoplastic polymers.

Thermosetting	Thermoplastic
a) Covalent bonds with cross- linking between chains. b) They are more strength and harder them thermo plastic.	a) They are liner chain without cross-linking and branching. b) they are usually supplied as granular materials

15. Define Epoxies

- **Characteristics:** Excellent combination of mechanical properties and corrosion resistance; dimensionally stable; good adhesion; relatively inexpensive; good electrical properties.
- **Application:** Electrical moldings, sinks, adhesives, protective coatings, used with fiberglass laminates.

16. Define Phenolics

- **Characteristics:** Excellent thermal stability to over 150o C; may be compounded with a large number of resins, fillers, etc.; inexpensive.
- Application: Motor housing, telephones, auto distributors, electrical fixtures.

17. What are metallic glasses?

Metallic glasses have the properties of metals and glasses such that they have ductility, malleability and brittleness. Ferromagnetic metallic glasses are in the form of ribbons and are used as light weight magnetic cores having no losses and high energy products.

18. What are advantages of FRP?

- High strength to weight ratio
- High heat resistance
- Low cost tooling
- High electrical conductivity

PART-B

1. Describe the molecular structure, properties and application of the following polymers.

I. Polyvinyl chloride (PVC)
II. Polystyrene (PS)
III. Polyethylene terephthalate (PET)
IV. Poly carbonate

Hints:

name	application example	T_g/°C	T_m/°C
	thermoplastics		
low-density polyethylene, LDPE	foils, electr. insulations	−110 ... −20	100 ... 110
high-density polyethylene, HDPE	tubes, bottles, household articles	−100 ... −20	125 ... 135
polypropylene, PP	tubes, food packages, electr. insulation	−20 ... 0	160 ... 175
polystyrene, PS	toys, acoustic or thermal insulation, packages	100	*am* / 270
polyvinyl chloride, PVC	tubes, packages, floor coverings, window frames	70 ... 90	*am* / 212
polymethylmethacrylate, PMMA	windows (e. g., in airplanes), lighting technology	100	*am*
polyamide, PA	gearwheels, ball bearing cages, bearings	40 ... 150	170 ... 300
polycarbonate, PC	casings, gearwheels, valves, tapes, packages	150	*am* / 220 ... 260
polytetrafluor ethylene, PTFE	gaskets, bearings, food industry	126[a]	327
polyethyleneterephtalate, PET	glues, connectors, roofings, tanks	80	*am* / 240 ... 250

2. **Explain engineering polymer in detail.**

Hints:

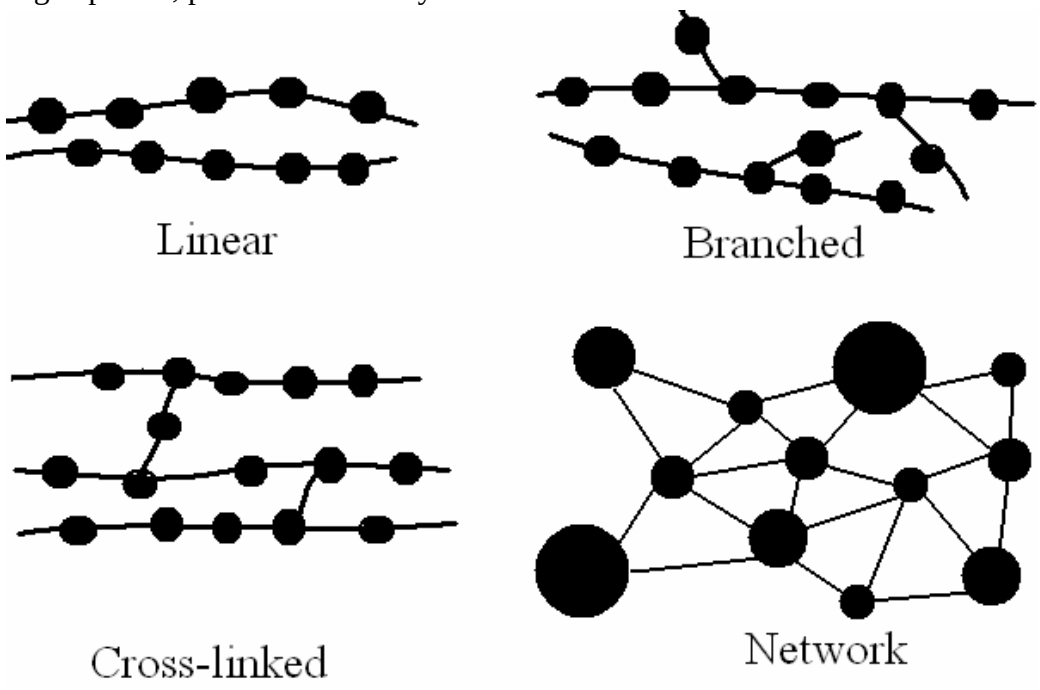
- Linear, where ‘mer’ units are joined together end to end insingle chains.

  E.g.: PVC, nylon.

- Branched, where side-branch chains are connected to mainones. Branching of polymers lowers polymer density becauseof lower packing efficiency
- Cross-linked, where chains are joined one to another atvarious positions by covalent bonds. This cross-linking isusually achieved at elevated temperatures by additive atoms.

  E.g.: vulcanization of rubber

- Network, trifunctional mer units with 3-D networks comesunder this category.
  E.g.: epoxies, phenol-formaldehyde.



3. **Describe the polymerization and additional polymerization.**

Hints:

Polymerization

- The synthesis of the large molecular weight polymers is termed polymerization;
- Monomer units are joined over and over, togenerateeach of the constituent giant molecules.
- Two general classifications—addition and condensation according to the reaction mechanism, as discussed below.

Addition Polymerization

- Addition polymerization (sometimes called chain reaction polymerization)
- The composition of the resultant productmolecule is an exact multiple for that of the original reactant monomer.
- Three distinct stages—initiation, propagation, and termination—are involvedin addition polymerization.

4. **Writeshort notes on FRP?**

Hints:

Polymer–Matrix Composites

- Polymer-matrix composites (PMCs) consist of a polymer resin1 as the matrix, with fibers as the reinforcement medium.

Glass Fiber-Reinforced Polymer (GFRP) Composites

1. It is easily drawn into high-strength fibers from the molten state.
2. It is readily available and may be fabricated into a glass-reinforced plastic economically using a wide variety of composite-manufacturing techniques.
3. As a fiber, it is relatively strong, and when embedded in a plastic matrix, it produces a composite having a very high specific strength.
4. When coupled with the various plastics, it possesses a chemical inertness that renders the composite useful in a variety of corrosive environments.

Carbon Fiber-Reinforced Polymer (CFRP) Composites

1. Carbon fibers have the highest specific modulus and specific strength of all reinforcing fiber materials.
2. They retain their high-tensile modulus and high strength at elevated temperatures; high-temperature oxidation, however, may be a problem.
3. At room temperature carbon fibers are not affected by moisture or a wide variety of solvents, acids, and bases.
4. These fibers exhibit a diversity of physical and mechanical characteristics, allowing composites incorporating these fibers to have specific engineered properties.
5. Fiber and composite manufacturing processes have been developed that are relatively inexpensive and cost effective.

5. **Differentiate thermosetting and thermoplastic polymers.**

Hints:

Thermosetting	Thermoplastic
a) Covalent bonds with cross- linking between chains. b) They are more strength and harder them thermo plastic. c) This process is not reversible hence, thermosets can not be recycled. d) E.g.: Acrylics, PVC, Nylons, Perspex glass, etc.	a) They are liner chain without cross-linking and branching. b) they are usually supplied as granular materials c) increasing ability to deform plastically with increasing temperature. d) E.g.: Acrylics, PVC, Nylons, Perspex glass, etc.

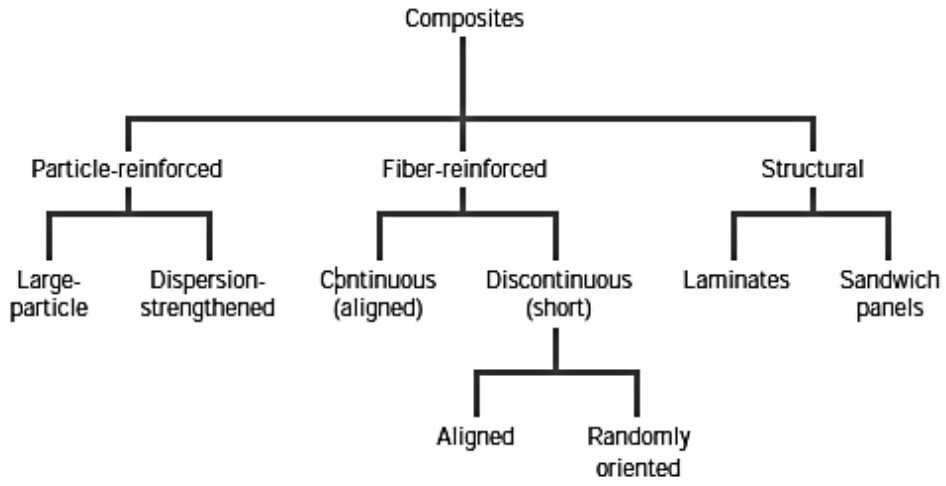
6. **Classify composite materials and list two properties and application of them.**

Hints:

Acompositeisamaterialthatconsistsofatleasttwodistinctmaterials.Thus,numbers of composites are possible.Foreaseofrecognition,theyareclassifiedbasedontwocriteria.

Basedontypeofmatrixmaterialasmetal-matrixcomposites,polymer-matrixcompositesandceramic-matrixcomposites.

Basedon size andshapedispersedphaseasparticlereinforcedcomposites,fiber-reinforcedcompositesandstructuralcomposites.


Composites
Particle-reinforced
Fiber-reinforced
Structural
Large-particle
Dispersion-strengthened
Continuous (aligned)
Discontinuous (short)
Laminates
Sandwich panels
Aligned
Randomly oriented