UNIT – III
PHASE RULE AND COMPOSITE
PART-A

1.Define Phase.

PHASE is defined as, "any homogeneous physically distinct and mechanically separable portions ofa system which is separated from other parts of the system by definite boundaries".

Ex: Air, a mixture of O_2, H_2, N_2, CO_2 and water vapor, etc., constitutes a single phase

2.Define Composite

A Composite is "a structural material which consists of combining of two or more constituents. The constituents are combined at macroscopic level and are not soluble in each other. One constituent is called reinforcing phase and the other one in which is embedded is called matrix.

3. Define Degree of Freedom.

Degree of freedom is defined as the minimum number of independent variable factors such as temperature, pressure and concentration of the phases, which must be fixed in order to define the condition of a system completely

A system having 1,2,3 or 0 degrees of freedom is called univariant, bivariant, trivariant and nonvariant respectively

4.Write any two merits of the Phase rule.

1. It is applicable to both physical and chemical equilibria.
2. It requires no information regarding molecular/microstructure, since it is applicable to macroscopic systems.
3. It is a convenient method of classifying equilibrium states in terms of phases, components and degrees of freedom.
4. It helps us to predict the behaviour of a system, under different sets of variables.

5.Define Triple Point.

At triple point all the three phases namely ice, water and vapour coexist. Thus the value of P is 3. Applying phase rule equation, the degree of freedom at this point is zero. It means that three phases can coexist in equilibrium only at a definite temperature and pressure. The values are 0.00750C and 4.58 mm respectively.

6. Write the uses of Phase diagram.

1. From the phase diagram, it is possible to predict whether an eutectic alloy or a solid solution is formed on cooling a homogeneous liquid containing mixture of two metals.
2. The phase diagrams are useful in understanding the properties of materials in the heterogeneous equilibrium system.
3. The study of low melting eutectic alloys, used in soldering, can be carried out using phase diagrams.

7. State the condensed phase rule

In a Solid ↔ Liquid equilibria, the gas phase is absent. So pressure variable is kept constant. Such system is called condensed system. The phase rule will be reduced by 1. F' = C – P + 1 It is known as reduced phase rule equation

8. $NH_4Cl(s)$ ---------NH_3 (g) + HCl (g). Write the values of P, F and C for this system?

P = 2; C = 1 ; F = C-P + 2 = 1 – 2 + 2 = 1

9. How many phases and components are present in the following system?
(i) $CaCO_3$ (s)---------- CaO(s) + CO_2 (g) &
(ii) PCl_5(s)---------- PCl_3(s) + Cl_2(g) at 500 C

(i)P = 3; C = 2 ; F = C – P + 2 = 2 – 3 + 2 = 1

(ii) P = 3; C = 2 ; F = C – P + 2 = 2 – 3 + 2 = 1

10. Write the need for composites

1) It has good strength , stiffness and toughness
2) It has high corrosion resistance
3) It has high wear resistance and chemical resistance
4) It has high environmental degradation resistance
5) It has low weight hence it consumes less fuel
6) It has high fatigue resistance
7) It is thermally, electrically and acoustically insulated material
8) It has high stability

11. Write the examples of natural and synthetic composite.

Natural composite

1) Wood when the lignin matrix is reinforced with cellulose fibres
2) Bone in which collagen is matrix and calcium phosphate reinforcement

Synthetic composite

Graphite/epoxy

Kevlar/epoxy

Carbonfiber/ epoxy

12. What is cured resin?

Liquid resin is combined with a curing fluid and then poured into a mold. Curing agent is mostly polymer with functional groups. Curing is nothing but polymerization reaction. When the liquid resin mixed with curing agent it undergoes polymerization and then it dried to get desired mold.

PART-B

1. Draw a neat one component water system and CO2 system and explain it. (16)
2. Draw a neat two component system with applications in detail.(8)
3. State Phase rule and explain the terms involved in it.(16)
4. Write short notes on Ceramic matrix composite ,Metal matrix and hybrid composite.(16)
5. Write a note on FRP composite (8)
6. Discuss the various reinforcement Materials its properties and advantages of its usage. (8)

UNIT – IV
FUELS AND COMBUSTION
PART-A

1. **Define Gross or high calorific value (GCV)**
   It is defined as the total heat generated when a unit quantity of fuel is completely burnt and the products of combustion are cooled to room temperature.

2. **Write the Dulong formula for GCV and NCV.**

   GCV=1/100 [8080(C)+34500(H-O/8)+2240(S)]Cals/kg.

   NCV =[GCV-9/100(H)x 587] Kcals/kg.

3. **Distinguish between proximate and ultimate analysis of coal**

S.No	Proximate analysis	Ultimate analysis
1	It involves the determination of weight percentage of moisture, volatile matter, fixed carbon and ash in coal	It involves the determination of weight percentage of carbon, hydrogen, sulphur and oxygen of the pure coal free from moisture and inorganic constituents

4. **What is metallurgical coke? Give the characteristics of metallurgical coke.**
   When Bituminous coal is heated strongly in the absence of air, the volatile matter escapes out and the
   mass become hard, strong, porous and coherent, which is called metallurgical coke. This process is
   called carbonization.
   Characteristics:
   1. Porosity: Coke should be highly porous.
   2. Strength: It should have high mechanical strength.
   3. Calorific Value: The calorific value of coke should be high.
   4. Purity, the moisture, ash, sulphur contents in metallurgical coke should be low.

5. **What is meant by Knocking?**
   The rate of ignition of the fuel gradually increases and the final portion of the fuel-air mixture gets ignited instantaneously producing an explosive sound known as "Knocking".

6. **Define octane number. How can it be improved?**
   The percentage by volume of isooctane in the isooctane-heptane mixture that matches the knocking characteristics of the fuel being tested is called the octane number.

Octane number can be improved by adding anti-knock agents like Tetra Ethyl Lead (TEL)

7. **Define cetane number. How can it be improved?**
   Cetane number is defined as, "the percentage of cetane present in a mixture of cetane and ∝- methyl naphthalene", which matches the fuel under test in ignition property.

8. **Define explosive range. Give examples.**
   The range covered by the lower and upper limits of the fuel is known as explosive range of the fuel.
   Examples: H2 (6 to 71), CH4 (6 to 13), petrol vapour (2 to 4.5)
   .

9. **What is the difference between caking coal and coaking coal?**
   When coal is heated strongly and if the mass becomes soft and plastic and fuses to give a coherent mass it is called caking coal.
   When coal is heated strongly and if the mass becomes hard, porous and strong then it is called coking coal.

10. **What are the requisites (or) characteristics of good metallurgical coke?**
    - Purity (moisture, ash, S & P should be low)
    - Porosity (when porous, O & C will have intimate contact and combustion will be uniform and complete)
    - Strength (high mechanical strength)
    - Calorific value (should be high)
    - Combustibility (easily burns)
    - Reactivity (low reactivity produces high temperature)
    - Cost (should be cheap)

PART-B

1, Discuss the proximate analysis and ultimate analysis of Coal.(16)
2. Explain flue gas analysis by ORSAT method.(8)
3. Describe the manufacture of synthetic petrol. By Bergius process(8)
4. What is Carbon foot print? Mention any 5important sources? How is lower carbon footprint (8)
5. Explain Ottohoffmann method with a neat diagram(8)
6. Define Green Hydrogen. Discuss the significance and challenges related to green Hydrogen(8).