Ref. No.: Ex/PRN/BS/B/T/216/2025

B.E. PRINTING ENGINEERING SECOND YEAR FIRST SEMESTER EXAM 2025

Subject: MATERIAL SCIENCE

Total marks: 100 **Time: 3 Hr.**

CO1

1. **a)** Classify the melting transition & glass transition of polymer by a comparative analysis between ceramic & polymer material with amorphous & semi-crystalline solid. **(5)**

b) Classify the different kind phase reaction in Iron-IronCarbide (Fe-Fe_3C) phase diagram along with its schematic diagram and briefly explain its respective steels present in different phase. **(10)**

c) Classify & describe the different effects of Silicon, Sulphur, Phosphorus on plain carbon steel. **(5)**

CO2 (any two)

2. **a)** Describe the atomic packing factor (APF) number for BCC & FCC structure along with its schematic diagram. **(5+5)**

b) Compute for BCC iron, (a) the interplanar spacing, and also deduce (b) the diffraction angle for the (220) set of planes. The lattice parameter for Fe is 0.2866 nm. Also, assume that monochromatic radiation having a wavelength of 0.1790 nm is used, and the order of reflection is 1.

(5+5)

c) State Bragg's law & its physical significance. Aluminium has atomic radius of 0.143 nm; an FCC crystal structure and atomic weight of 26.98 g/mol. Compute its theoretical density and compare the answer with its measured density (2.7 g/cm^3). **(4+6)**

CO3 (any two)

3. **a)** Demonstrate the Fick's 2^{nd} law of diffusion flux for steady state diffusion. An alloy that initially has a uniform carbon concentration of 0.25 wt% and is to be treated at 950°C (1750 F). If the concentration of carbon at the surface is suddenly brought to and maintained at 1.20 wt%, how long will it take to achieve a carbon content of 0.80 wt% at a position 0.5 mm below the surface? The diffusion coefficient for carbon in iron at this temperature is 1.6×10^{-11} m^2 /s assume that the steel piece is semi-infinite.

(4+6)

b) Differentiate between vacancy diffusion & interstitial diffusion. Short note on Condensation polymerization or Photopolymers. Define diffusion flux (J) & concentration gradient.

(4+2+2+2)

c) Demonstrate the Fick's 1^{st} law of diffusion flux for steady state diffusion. A plate of iron is exposed to a carburizing (carbon-rich) atmosphere on one side and a decarburizing (carbon-deficient) atmosphere on the other side at 700°C. If a condition of steady state is achieved, derive the diffusion flux of carbon through the plate if the concentrations of carbon at positions of 5 mm and 10 mm beneath the carburizing surface are 1.2 and 0.8 kg/m^3. Assume a diffusion coefficient of 3×10^{-11} m^2 /s at this temperature.

(4+6)

CO4 (any two)

4. **a)** What is basic volumetric flowrate & represent it in steady-state condition? Define permeability coefficient (P_m). Describe the modified Fick's 1^{st} law of steady-state diffusion through polymer membranes.

(3+3+4)

b) Define vulcanization along with its reaction & explain the stress-strain curve of the same. Why vulcanization is important for printing? Describe Newton's law of viscosity. **(3+3+2+2)**

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c) Differentiate between Newtonian & Non- Newtonian fluid. Differentiate between Thermoplastic Vs thermosetting polymer. **(5+5)**

d) Short note (any two): Amino resins, Phenol, Surfactants, Disperse dye, Emulsifier. **(5+5)**

CO5

5. a) Describe the density of totally crystalline polyethylene (C_2H_2). The orthorhombic unit cell for polyethylene has a unit cell volume (V_c) of 9.33 x 10^{-23} cm^{-3}/unit cell and also the equivalent of two ethylene repeat units is contained within each unit cell. Also calculate the percent crystallinity of a branched polyethylene that has a density of 0.925 g/cm^3. The density for the totally amorphous material is 0.87 g/cm^3.

b) Metal plate of area 2.5x10^{-4} m^2 is placed on a 0.25x10^{-3} m thick layer of castor oil. If the force of 2.5 N is needed to move the plate with velocity of 3x10^{-2} m/s. Calculate the coefficient of viscosity of castor oil.

c) Deduce the total pressure inside the spherical soap bubble.

d) The histogram table (as shown in below figure) consist of molecular weight (in 10^3gm/mol) vs number fraction (x_i) and weight fraction (w_i) for PE. Find (a) the number-average molecular weight & (b) the degree of polymerization. **(4x5)**