



**WEST BENGAL STATE UNIVERSITY**  
B.Sc. Honours 6th Semester Examination, 2022



**CEMADSE06T-CHEMISTRY (DSE3/4)**  
**POLYMER CHEMISTRY**

Time Allotted: 2 Hours

Full Marks: 40

*The figures in the margin indicate full marks.  
Candidates should answer in their own words and adhere to the word limit as practicable.  
All symbols are of usual significance.*

**Answer any three questions taking one from each group**

**GROUP-A**

**(Unit 1, 2 and 3)**

- What is meant by constitutional repeating unit (CRU) of a polymer? Demonstrate, how it differs from repeating unit using polyethylene as an example. 1+2
  - What is functionality factor? Assuming a value of 0.999 for  $p$  (extent of reaction), what would be the DP of a polyester prepared from equimolar quantities of difunctional reactants in the presence of 1.5 mol% of acetic acid? Let the mol% difunctional reactants both be 98.5. 1+3  

$$\left[ \text{Given, } DP = \frac{2}{2 - pf_{avg}} \right]$$
  - Differentiate between suspension polymerization and emulsion polymerization. 2
  - Show that for cationic polymerization rate of propagation is proportional to the square of monomer concentration (if the termination occurs via simple dissociation of the macro carbocation gegenion complex). 4
- Explain, why nylon 6,6 has a higher melting temperature than nylon 6,10. What is meant by cohesive energy density of a polymer? 2+1
  - Derive Carothers' expression relating average functionality, extent of reaction and degree of polymerization for polycondensation reaction carried out for a time period  $t$ . 3
  - What is the role of inhibitor in free radical polymerization? The following are data for the polymerization of styrene in benzene at 60°C with benzoyl peroxide as the initiator.  $[M] = 3.34 \times 10^3 \text{ mol/m}^3$ ,  $[I] = 4.0 \text{ mol/m}^3$ ,  $k_p^2/k_t = 0.95 \times 10^{-6} \text{ m}^3/\text{mol-s}$ . If the spontaneous decomposition rate of benzoyl peroxide is  $3.2 \times 10^{-6} \text{ s}^{-1}$ , calculate the initial rate of polymerization. 3
  - Show that for a self catalyzed polyesterification reaction of a glycol and a dicarboxylic acid (assume equimolar presence of two components) plot of  $1/(1-p)^2$  vs time is a straight line. [ $p$  is the extent of reaction]. 4

**GROUP-B**  
**(Unit 4, 5, 6 and 7)**

3. (a) Outline the factors on which the degree of crystallinity of a polymer depends. 2  
 (b) Explain, why atactic polystyrene is amorphous while the isotactic variety is semi crystalline. 2  
 (c) Schematically represent how specific volume changes at glass transition temperature ( $T_g$ ). Briefly describe, how the volume changes inside a polymer when the glass transition temperature is crossed. 2  
 (d) What do you mean by polydispersity index (PDI)? How PDI is significant in polymer study? 2  
 (e) The following data were obtained in the determination of average weight of a polymer, 4

Molecular weight	Weight (g)
80,000	1.0
50,000	3.0
30,000	5.0
10,000	6.0

Calculate, (i) Number average molecular weight  $M_n$  (ii) Weight average molecular weight  $M_w$  and (iii) Polydispersity index.

- (f) What is polymorphism? Name a polymer which exhibits polymorphism. 2
4. (a) Discuss in brief, the theory underlying the determination of viscosity average molar mass of a sample of polymer by measurement of viscosity. 3  
 (b) Discuss why polymers crystallize in a chain folded fashion rather than the thermodynamically preferred extended chain form. 3  
 (c) Osmotic pressure measurement of a polymer solutions at 27°C yielded a plot of  $\pi/C$  vs  $C$ , which on extrapolation to zero concentration gave an intercept with ordinate equal to  $3.47 \times 10^{-4}$  litre atmosphere/g. What is the molecular weight of the polymer? 3  
 (d) (i) What is the major difference between glassy state and molten state of a polymer? 1  
 (ii) Why is glass transition temperature,  $T_G$  referred as a second order transition? 2  
 (e) Explain, why insertion of rigid bulky groups, like aromatic rings in linear aliphatic polymer chains significantly enhance their physical properties. 2

**GROUP-C**  
**(Unit 8 and 9)**

5. (a) Using Flory-Huggins theory for polymer solution, deduce an expression for the entropy of mixing. 5  
 (b) Write short note on (any *two*): 3+3  
 (i) Polyacrylamide, (ii) Novalac resin, (iii) Poly (vinyl acetate)  
 (c) Describe the synthesis of polyaniline. 2

6. (a) What do you mean by Hildebrand solubility parameter ( $\delta$ )? Under what condition (with reference to  $\delta$ ) solubility becomes an entropy effect? 2
- (b) How the Flory-Huggins parameter ( $\chi_{12}$ ) is related to Hildebrand solubility parameters  $\delta_1$  and  $\delta_2$ ? 2
- (c) How can you prepare polyurethanes commercially? Explain, why the melting point of polyurethane is much less than that of the corresponding polyamide. 3
- (d) What are polycarbonates? How can you prepare a polycarbonate using bisphenol-A and diphenylcarbonate? 3
- (e) What do you mean by synthetic metal? Mention two conditions for a polymer to be conducting. 3

**N.B. :** *Students have to complete submission of their Answer Scripts through E-mail / Whatsapp to their own respective colleges on the same day / date of examination within 1 hour after end of exam. University / College authorities will not be held responsible for wrong submission (at in proper address). Students are strongly advised not to submit multiple copies of the same answer script.*

—x—