

# Indian Institute of Technology Guwahati

## Mid-Semester Examination

### Course: Polymer Science & Technology (CL-623)

Duration: 2 hours

Total Marks: 40

Date: 24/09/2022

Timing: 09:00-11:00

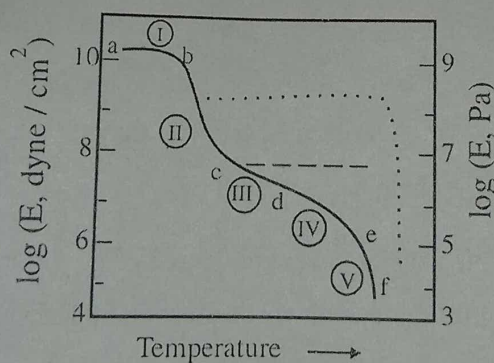
Note:

- Answer all questions.
- Please write your answer precisely.

Q1. Explain the following:

[6x2]

- Presence of flexible pendant groups reduces the glass transition of the polymer, whereas bulky or stiff side groups increase it. Why?
- Working principle of Gel Permeation Chromatography with proper schematic.
- Consider that you are given with a Zimm plot. What interpretation can you make out of that.
- Out of Ostwald, Cannon-Fenske, and Ubbelohde type viscometers, which one will measure the solution viscosity effectively.
- Explain the difference between Fossil and plant derived polymers based on carbon footprint considering cradle to cradle approach.
- Explain viscoelastic behaviour for linear amorphous polymers & characteristics of polymer in highlighted five (I, II, III, IV, V) regions.



Q2. What is the degree of polymerization of each of the following polymers with molar mass 100,00 g/mol? [3]

- poly(lactic acid)
- poly(caprolactone)
- poly(butylene succinate)

**Q3.** A polymer **P** having number-average and weight-average molecular weights of 120,000 Da and 300,000 Da respectively, was cut into fractions **A** and **B** by fractional precipitation. If **A** and **B** have number-average molecular weights of 90,000 Da and 130,000 Da respectively, what are the weight fractions of **A** and **B** obtained from the initial polymer **P**? If **A** and **B** have the same polydispersity, what is the polydispersity index? [4]

**Q4.** Identify the given polymers as to whether they are condensation or addition polymers. [4]

- i. Poly(lactide)
- ii. PVDF

- iii. Kevlar
- iv. Poly(lactic acid)

**Q5.** A real polymer chain consisting of  $n$  bonds each of length  $l$  may be usefully represented according to valence angle model of  $N$  links each of length  $b$  with backbone bond angles equal to  $\theta$  such that it will have the same end-to-end distance and the same contour length. Obtain  $N$  and  $b$  in terms of the characteristic ratio  $C_\infty$  of the polymer chain. [4]

**Q6.** For what purpose the Carothers theory is helpful. Provide the expression for a case considering the equal reactivity theory. Also explain why the monomer's purity is important in a step growth polymerization. [4]

**Q7. (a)** Calculate the root mean square end-to-end distance and the radius of gyration for a molecule in molten polypropylene of molecular weight  $10^5$ .

[Data: carbon-carbon bond length =  $1.54 \times 10^{-8}$  cm; tetrahedral bond angle  $109.5^\circ$ ; steric parameter,  $\sigma = 1.6$  at  $140^\circ\text{C}$ .]

**(b)** How extensible is the molecule? (Hint: Calculate the ratio of the extended chain length to the average chain end separation. [5]

**Q8.** A new polymer with a weight average degree of polymerization of 1400 and five atoms in the repeating unit has a melt viscosity of 1500 poises at  $190^\circ\text{C}$ . What will be the viscosity at the same temperature if its molecular weight is doubled? [4]

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