

Major

Date: 23/11/15 Open Book & Open Notes Marks: 32

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Note: Supplementary answer sheets will not be provided

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1. A polymer material, obtained by step polymerization, consists of linear chains with repeat units of weight 100 Da. The probability of a chain with  $N_{ru}$  number of repeat units is  $10^5/N_{ru}^2$ . The smallest chain of the polymer sample has  $10^5$  repeat units, while the longest chain has one million repeat units.
  - a. [6 + 6 Marks] What is number-average and mass-average molecular weights of the polymer sample?
  - b. [5 Marks] The number-average degree of polymerization for 3600 s of reaction time is 500000 while it is 600000 for reaction time of 4600s. If reaction rate is second order and the reaction rate constant is  $1 \text{ m}^3/\text{mol}/\text{s}$ , what was the initial concentrations of each of the monomers (initial reaction mixture contained equal concentrations of the two monomers)?
  
2. [1.5 + 6 + 1.5 Marks] Phase transition of a material from liquid to solid state follows the nucleation and growth mechanism. Is the phase transition spinodal? why? If the rate of thermally-activated growth process doubles on decreasing temperature from  $150^\circ\text{C}$  to  $120^\circ\text{C}$ , what is the change in Gibbs free energy for one mole of liquid converting to solid? Assume simple Arrhenius type growth rate expression. If the growth rate mechanism is martensitic, what would be the change in the growth rate for the same change of temperature?
  
3. [6 Marks] The corrosion potential of iron immersed in deaerated acidic solution of  $\text{pH} = 3$  is  $-0.50 \text{ V}$  as measured at  $25^\circ\text{C}$  with respect to the standard hydrogen electrode. Calculate the corrosion rate of iron in millimeters per year, assuming the Tafel slope of the cathodic polarization curve,  $\beta_c$ , equals  $0.1 \text{ V/decade}$  and the hydrogen ion exchange current,  $i_0$ , is  $0.1 \times 10^{-6} \text{ A}/\text{cm}^2$ . Density and atomic weight of iron are  $7.87 \text{ g}/\text{cc}$  and  $55.85 \text{ Da}$ , respectively.

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END

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