B.E. CHEMICAL ENGINEERING FOURTH YEAR FIRST SEMESTER - 2018

Interfacial Science and Engineering

Time: Three Hours

Full marks: 100

*Answer **any four** questions.*
Assume any missing data.
Write all assumptions clearly.

1. (a) Define work of adhesion, cohesion and spreading with help of pictorial diagram. [6]
(b) Define coalescence and aggregation. Give examples of processes or products in which aggregation (i.e., coagulation) is desirable. [5]
(c) Classify colloidal dispersions interns of the physical states of the internal and external phases with examples. [4]
(d) Phosphatidylcholine micelles are spherical particles having a molecular weight of 97,000 g $mole^{-1}$. Assuming that the density of the dry lipid ($\rho = 1.018$ g cm^{-3}) applies to the micelles, calculate the radius R_s, and the diffusion coefficient D for these particles in water at 200°C. The experimental value of the diffusion coefficient is 6.547×10^{-7} cm^2 s^{-1} under these conditions. Evaluate f/f^* and estimate the hydration of the lipid. [10]

2. (a) The contact angle of water on a solid surface is 53.7°. The contact angle of glycerol on the same solid surface is 52°. Octane ($\gamma = \gamma^{LW}$=21.8mJ/m2) completely wets the same surface. Calculate the interfacial tension of the solid surface. Data are given below. [8]

Liquid	γ^{LW} (mJ/m^2)	γ^{+}(mJ/m^2)	γ^{-}(mJ/m^2)	γ (mJ/m^2)
Water	21.8	25.5	25.5	72.8
Glycerol	34	3.92	57.4	64

(b) Derive an expression for height of a meniscus of a wall. [10]
(c) What should be the speed of an ultracentrifuge so that the boundary associated with the sedimentation of a particle of molecular weight 60,000 g $mole^{-1}$ moves from $r_1 = 6.235$cm to $r_2 = 6.658$ cm in 5 min? The densities of the particle and the medium are 0.998 and 0.728 g cm^{-3}, respectively, and the friction factor of the molecule is 5.3×10^{-11} kg s^{-1}. [7]

3. (a) What are the three van der Waals forces, and what is the molecular origin of each of them? [10]
(b) Explain how Hamaker constants for interaction between identical materials in vacuum can be used to determine Hamaker constants for interaction between dissimilar materials immersed in an arbitrary medium. [10]
(c) What are the common sources of interfacial charges? Explain with pictorial diagram. [5]

4. (a) Explain Gouy-Chapman theory. In what way does the Gouy-Chapman theory extend the Debye-Huckel approach? [10]

(b) Describe the physical significance of the Debye-Huckel parameter K. How does it vary with the bulk concentration n, for a 1 : 1 electrolyte? How does it vary with ionic charge for a constant bulk concentration? [10]
(c) What are the basic differences between solutions, suspensions and colloids? [5]

5. (a) Illustrate with appropriate interaction energy curves of unstable, metastable and stable dispersions. [6]
(b) Explain sol-gel method using one example. [8]
(c) Why does a drop of pentane spread into a thin film when placed on a water surface, whereas a larger hydrocarbon such as dodecane breaks up into smaller droplets? [6]
(d) Explain different steps of photolithographic technique. [5]