Ref. No. : Ex/ChE/T/414F/2019

**B.E. CHEMICAL ENGINEERING FOURTH YEAR FIRST SEMESTER – 2019**

**INTERFACIAL SCIENCE AND ENGINEERING**

**Time: 3 hrs** **Full Marks: 100**

**Answer all the Questions**

1. (a) A spherical particle suspended in water is placed in a centrifugal field. The rotational speed of the particle is 600 rad/sec and the particle moves from 5 cm to 7 cm in 90 s. Calculate the area of the particle. Density of the particle is 8000 kg/m$^3$.
(b) The diffusion coefficient of a colloid particle in water at 293 K is $4.5*10^{-10}$ m$^2$/s. Estimate its diffusion coefficient in ethylene glycol at 313 K. Given: viscosity of ethylene glycol at 313 K is 12.5 mPa s.

Or

The variation of osmotic pressure with the concentration of nitrocellulose in methanol is given below. Determine the molecular weight of nitrocellulose from these data.

| $c$ (kg/m$^3$) | 0.7 | 1.9 | 6.7 | 12.1 |
|---|---|---|---|---|
| $\frac{\pi_o}{RTc}$ (mol/kg) | 0.011 | 0.012 | 0.015 | 0.021 |

(c) Write a short note on Donnan Equilibrium. What is the difference between Rayleigh scattering and Mie scattering?

Or

Write the physical significance of Deborah Number and Peclet number. Define Packing parameter.
(d) An aqueous solution of sodium chloride is placed inside a capillary in an electro-osmosis apparatus and subjected to an electric field of 200 V/m. The electro-osmotic velocity in the capillary is observed to be 10 μm/s. Calculate zeta potential from these data. (8+5+4+2+6).

2. (a) Write down the importance of fowkes correlation. Show that the ratio between interaction force/unit area of a sphere and planar half-space and interaction energy/unit area between plane parallel half-spaces is independent of Hamaker Constant.

Or

Draw the profile of potential variation ($\psi$) with the distance $x$. Derive the expression supporting the profile. Write down the effect of temperature on surface tension.
(b) 0.15 gm of polymer is dissolved in 150 ml of butanone solution. The flow time at ambient temperature is measured to be as follows:
Flow time $_{\text{Butanone}}$ = 120 sec and Flow time $_{\text{Polymer solution}}$ = 160 sec. Determine the molecular weight of the polymer.
(c) How the Equivalent Conductivity and Turbidity of surfactant molecules change in the vicinity of CMC (3+8+9+5)

3. (a) Derive the expression for BET adsorption isotherm. State the reasons behind the thermodynamic instability of the emulsions.

Or

Write a short note on: (i) 6-12 potential; (ii) Electroviscous effect; (iii) Debye Length

[ Turn over

(b) The interfacial tension between an oil and water is 100 mN/m. The density of oil is 900 $kg/m^3$. If the angular velocity has been altered from 100 rad/s to 1000 rad/s, calculate the % change in area of the cylindrical drop.
(c) Water has a surface tension of 0.4 N/m. In a 3 mm diameter vertical tube if the liquid rises 6 mm above the liquid outside the tube, calculate the contact angle. (12+9+4)

4. (a) Write down the mechanism of Chemical Vapour Deposition or Photolithography. (Show the schematic).
(b) Write down the steps of $CuAlO_2$ by DC-sputtering technique.
(c) Choose the correct answer (any three):
(i) The S.T. of soap solution is $25 \times 10^{-3}$ N/m. the excess of pressure inside a soap bubble of diameter 1 cm is
(a) 10 Pa (b) 20 Pa
(c) 5 Pa (d) None of these
(ii) Work done in blowing a soap bubble of diameter 2cm, is (S.T. = $3 \times 10^{-2}$ N/m)
(a) $7.54 \times 10^{-5}$ J (b) $7.54 \times 10^{-6}$ J
(c) $7.54 \times 10^{-3}$ J (d) 7.54 J
(iii) Water rises up to a height $h_1$ in a capillary tube of radius r. the mass of the water lifted in the capillary tube is M. if the radius of the capillary tube is doubled, the mass of water that will rise in the capillary tube will be
(a) M (b) 2M
(c) M/2 (d) 4M
(iv) In a surface tension experiment with a capillary tube water rises up to 0.1 m. if the same experiment is repeated on an artificial satellite which is revolving around the earth. The rise of water in a capillary tube will be
(a) 0.1 m (b) 9.8 m
(c) 0.98 (d) Full length of capillary tube (8+8+9)