INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Mid-Spring Semester Examination, 2018-2019

***Subject*: Instability and Patterning of Thin Polymer Films *Subject No*.: CH 62052**

***Date*: *Time*: 2 Hrs *Full Marks*: 30 No. of Students: 44**

***Instructions*:**

1. All Questions are compulsory.
2. **Be Precise with your answers. Long, redundant answers can potentially fetch zero!**
3. **Use Figures as and When Necessary**

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1. (a) You would like to use contact angle goniometry with suitable probing liquids to measure the surface tension of a solid substrate. What is the limiting value of surface tension you can predict and why? (1)

(b) Equilibrium contact angles of Diodomethane, Water and Glycerol are 39.4°, 60.9° and 63.1° respectively on clay surface. (3)

Calculate the LW and AB components and the total of Surface tension of Clay.

Data Given (mJ/m^2):	γ^{LW}	γ^-	γ^+	γ_{Total}
Water	**21.8**	**25.5**	**25.5**	**72.8**
Diodomethane	50.8	0	0	50.8
Glycerol	34.0	57.4	3.2	64.0

(c) What are Cassie and Wenzel States of Wetting? How does the apparent equilibrium contact angle change on a patterned surface for a material that is exhibiting Wenzel state of wetting? Is it possible under any condition to obtain apparent hydrophobicity with a hydrophilic base material? (1+1.5+1.5=4)

Total Marks in Question 1: (8)

2. Two identical colloidal particles are immersed in a liquid. Explore all possible cases and comment on the conditions of colloidal stability. T***otal Marks in Question 2: (4)***

3. (a) Derive the Young Laplace Equation for an arbitrarily curved surface at a point where the two orthogonal Radii of curvature are R_1 and R_2. What is the limitation of this form of the equation? (2)

(b) Draw an arbitrary axisymmetric surface and show (based on proper, detailed figures and all appropriate assumptions) how you would write down the expressions for its area and volume. (2)

(c) Why is the liquid side pressure lower if it has a concave meniscus? (2)

(d) What is the role of surface tension in spontaneous instability of thin films? (2)

Total Marks in Question 3: (8)

4. (a) Show that for a thin film, $G_{Film}^{LW} = -G_{Interface}^{LW}$. Find out the expression of G_{Film}^{LW}. (1+2)

(b) Obtain an expression for the Excess Interfacial Free Energy (ΔG_{Ex}^{LW}) for a thin film of material 2 coated on a semi infinite substrate of materials 1. (2)

(c) Define Effective Interface Potential, Conjoining Pressure and Disjoining Pressure. (2)

(d) Discuss how the Sign of $\boldsymbol{A_E}$ can be correlated to film stability. (2)

(e) Show that $\boldsymbol{A_{12}} = \sqrt{(A_{11}.A_{22})}$ (1)

Total Marks in Question 4: (10)

Useful Expressions:

1) $G^{lw}(d) = -\left(\frac{A_{12}}{12\pi}\right)\left[\frac{1}{(d_1+d_2+d)^2} + \frac{1}{d^2} - \frac{1}{(d+d_1)^2} - \frac{1}{(d+d_2)^2}\right]$

2) $A_{12} = (\rho_1\rho_2\pi^2 N_A{}^2\beta_{12})/(M_1M_2)$

3) $\gamma_{12}^{AB} = 2\left[\sqrt{\gamma_1^+\gamma_1^-} + \sqrt{\gamma_2^+\gamma_2^-} - \sqrt{\gamma_1^+\gamma_2^-} - \sqrt{\gamma_2^+\gamma_1^-}\right]$