B. Tech III Year I Semester Examinations, December-2011
TRANSPORT PHENOMENA IN BIOPROCESSES
(BIO-TECHNOLOGY)

Time: 3 hours   Max. Marks: 75
Answer any five questions
All questions carry equal marks

1.a) What is meant by the term "Non-Newtonian"? What types of substance exhibit this behaviour?
  b) Describe about the "cone-and-plate viscometer".   [7+8]

2.a) Discuss about the equation of motion.
  b) Define the terms 'friction factor' and 'drag coefficient'.   [9+6]

3.a) Compare Fourier's law of heat conduction with Newton's law of viscosity?
  b) Discuss the effect of T and P on thermal conductivity of gasses and liquids.
                                                 [7+8]

4. Derive the temperature distribution in a semi-infinite slab.   [15]

5. Write short notes on the following:
   a) Boundary layer theory   b) Film theory   c) Role of diffusion in bioprocessing
                                                  [15]

6. Estimate the rate of absorption of CO_2 into a water film flowing down a vertical wall 1m long at the rate of 0.05 kg/s per meter of width at 25^0C. The gas is pure CO_2 at 1 std atm. The water is essentially CO_2-free initially. The solubility of CO_2 in water at 25^0C, 1 std atm, is C_{Ai} = 0.0336 kmol/m^3, μ = 8.9 x 10^{-4} kg/ms, D_{AB} = 1.96 x 10^{-9} m^2/s, solution density = 998 kg/ m^3, Γ = 0.05 kg/ms, L = 1m.
                                                  [15]

7.a) Write some applications of mass transfer in bioprocessing.
  b) Explain the process of mass transfer by convection.   [8+7]

8. Discuss the following
   a) Oxygen uptake in cell cultures b) antifoam agents   [8+7]

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1.a)   What is Newton's law of viscosity? Explain
  b)   How does the viscosity vary with T and P for dilute gases and liquids?   [6+9]

2.   Derive the equations for friction factor in packed columns?   [15]

3.a)   Describe the analogy between heat and momentum transfer?
  b)   Compare the temperature dependence of thermal conductivity for gases, liquids
       and solid.   [7+8]

4.   Derive the temperature distribution in a semi- infinite and finite slab.   [15]

5.a)   Compare Fick's law of diffusion with Newton's law of viscosity and Fourier's
       thermal conductivity. To what extent are these three relations analogous?
  b)   Discuss the role of diffusion in bioprocessing.   [8+7]

6.   Describe about boundary layer theory and penetration theory.   [15]

7.a)   Explain the process of mass transfer by convection.
  b)   Write short notes on liquid- solid mass transfer.   [7+8]

8.   Describe about the following.
       a) Oxygen balance method
       b) Oxygen transfer in fermentor   [7+8]

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1.a) How do you measure the viscosity using coaxial cylinder rotary viscometer.
  b) Discuss about the rheological properties of fermentation broth.   [7+8]

2. Derive the equations for friction factor when the fluid is flowing in tubes. [15]

3. A plastic panel of area A=900 cm^2 and thickness Y=0.6cm was found to conduct heat at a rate of 3.5 watts at steady state with temperatures of T_0 =25^{0}C and T_1=25^{0}C on the two main surfaces. What is the thermal conductivity of the plastic in cal/m sec K?   [15]

4. Derive the temperature distribution in a Stirred Tank Reactor when the flow is turbulent.   [15]

5.a) Discuss about boundary layer theory and film theory
  b) What does the Corrsin equation describe?   [8+7]

6.a) Define mass transfer coefficient and derive the equations to calculate mass transfer coefficient
  b) Discuss about penetration theory.   [7+8]

7.a) What are the various correlations for evaluating mass transfer coefficient?
  b) Write short notes on liquid- liquid mass transfer?   [7+8]

8.a) What are the factors affecting cellular oxygen demand ? Explain
  b) Discuss about oxygen uptake in cell cultures.   [8+7]

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1.a) Discuss about impeller viscometer.
 b) What is meant by the term "Non-Newtonian"? What types of substance exhibit this behavior? [8+7]

2.a) Give the physical significance of the three derivatives *in which T is the local fluid temperature.*
 b) What is continuity equation? Explain. [10+5]

3. A plastic panel of area A=929 cm^2 and thickness Y=0.64 cm was found to conduct heat at a rate of 3 watts at steady state with temperatures of $T_0 = 24^0$C and $T_1 = 26^0$C on the two main surfaces. What is the thermal conductivity of the plastic in cal/m sec K? [15]

4. Derive the temperature distribution for a Stirred Tank Reactor and discuss the relationship between cell concentrations & stirred conditions. [15]

5.a) What is diffusion? What factors may cause diffusion to occur?
 b) Discuss the analogy between mass, heat and momentum transfer. [7+8]

6.a) Discuss about penetration theory.
 b) In an aerobic fermentation process, the typical average bubble diameter is 3 mm, with an average raise velocity of 18cm/s. If the diffusivity coefficient is 8x10^{-10} m^2/s, find the mass transfer coefficient on the basis of penetration theory. [5+10]

7.a) Write some applications of mass transfer in bioprocessing.
 b) Write short notes on gas- liquid mass transfer. [8+7]

8.a) Discuss about the measurements of k_La using dynamic method.
 b) What are the factors affecting cellular oxygen demand? Explain. [8+7]

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