Exam. Code: 0909
Sub. Code: 6311

2122

B.E. (Biotechnology) Fifth Semester

BIO-514: Transport Phenomena

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: ***Attempt five questions in all, including Question No. 1 which is compulsory and selecting two questions from each Section. State all assumptions.***

x-x-x

1a). Discuss how viscosity of liquids vary with temperature and pressure.

b). Define Schmidt number and Lewis number

c). Explain the Fourier's law of heat conduction.

d). Discuss the term 'Diffusion controlled reaction'.

e). Suppose that the apparent viscosity of blood is measured in a Couette viscometer. Discuss how the apparent viscosity at one shear rate might change with time. (10)

SECTION-A

2a). For an incompressible fluid flowing over a flat plate the velocity profile is given by $V = 3y^{\frac{2}{3}}$ where, V is the velocity in m/s at a distance y meters above the plate. The viscosity of the fluid is 8.2 poise. Determine the shear stress at y = 0 and y = 4 cm.

b). Two parallel plates are 10 cm apart. The bottom plate is stationary and the top plate is moving at a velocity of 30 cm/s. The fluid between the plates is water which has a viscosity of 1 cP. If water is replaced with a fluid of viscosity 10 cP and the momentum flux is to remain same as that for the case of water, what should be the velocity of the top plate? (5,5)

3. In a gas absorption experiment a viscous fluid of density ρ and viscosity μ flows upwards through a small circular tube of radius R, length L and then downward on the outside. Set up a momentum balance over a shell of thickness Δr in the film to find the velocity distribution in the falling film of thickness δ. Neglect end effects. (10)

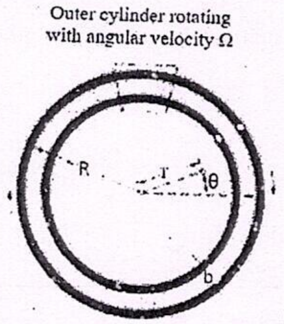
4a). Discuss the analogy between momentum and heat transfer with respect to the governing equation and the transport mechanism.

b). Determine the rate of diffusion for a drug dissolving through the stomach lining if C_1 is 60 mg/L and C_2 is 300 mg/L. The diffusivity constant of the drug is 2.9×10^{-10} cm^2/s and the thickness of the stomach lining is 5 mm. (5,5)

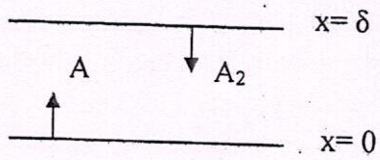
SECTION-B

5. The power consumption by impeller P in geometrically similar fermenters is a function of the diameter and speed N of the impeller, density ρ and viscosity μ of the liquid and acceleration due to gravity g. Determine appropriate dimensionless parameters that can relate power consumption using the Buckingham Pi theorem. (10)

6. For the flow of an incompressible Newtonian fluid between two coaxial cylinders, the inner surface of the cylinder is maintained at a temperature T_0 while at the outer surface the flux is zero. The volume heat source resulting from friction between adjacent layers of the fluid (viscous dissipation) can be designated as S_v. Make an energy balance over a shell of thickness Δx, width W and length L to derive an equation for temperature profile in the slit. Assume the slit width **b** is small with respect to the radius R of the outer cylinder. (10)



7. In a catalytic reactor a reaction 2A→B is carried out. Assume that each catalyst particle is surrounded by a stagnant gas film of thickness δ, through which A diffuses to reach the catalyst surface, at the surface the reaction occurs instantaneously and the product B then diffuses out of the film thickness to the main turbulent stream composed of A and B. Using shell mass balance obtain an expression for the concentration profile in the gas film and the molar flux of the reactant through the gas film. Assume that the gas film is isothermal. (10)



x-x-x