Code No: **R41081** **R10** **Set No. 1**

IV B.Tech I Semester Supplementary Examinations, October/November - 2017

TRANSPORT PHENOMENA

(Common to Chemical Engineering & Petroleum Engineering)

Time : 3 hours **Max. Marks: 75**

Answer any FIVE Questions

All Questions carry equal marks

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1 a) Write a note on Newton's, Fourier's and Fick's laws. List out the similarities and differences. [10]

b) A power law fluid with parameters m = 2 (N/m^2) $(s)^{0.8}$ is placed between two parallel plates. The lower plate is moved with a velocity of 0.3 m/s. Calculate the shear stress at the lower plate. Assume the flow to be laminar. [5]

2 a) Outline the procedure to solve viscous flow problems. [3]

b) Show that for the flow of a liquid along an inclined plate is

$$\delta = \sqrt{3\mu\langle V_z\rangle / \rho\, g\cos\beta} \quad = \quad \sqrt[3]{3\mu\,\dot{m} / \rho^2 g\cos\beta}$$

Where δ = liquid film thickness

β = angle of inclined plate with the vertical axis

$\dot{m}$ = mass flow rate per unit width of the plate [12]

3 a) Compare forced and free convection heat transfer with respect to the determination of temperature profiles and Nusselt number. [5]

b) A catalytic reaction is being carried out at constant pressure in a packed bed between coaxial cylindrical walls within inner radius r_o and outer radius r_1. The entire inner wall is at temperature T_0. There is no heat transfer through this surface. The reaction releases heat that is at a uniform volumetric rate S_c throughout the reactor. If K_e is the effective thermal conductivity, derive a second order differential equation that describes the temperature profile by shell energy balance. Also find the maximum temperature. State the boundary conditions used. Neglect the temperature gradients in the axial direction. [10]

4 a) In solving shell mass balance equations what are the commonly employed boundary conditions. [4]

b) Derive concentration profile for the catalytic reaction 2A→B. The reaction is not instantaneous at the catalytic surface at z = δ. [11]

5 a) Write forms of equation of energy for gases, liquids and solids. Indicate the special form of equation of energy for an ideal gas. [5]

b) Derive Navier- Stokes equation from first principles of momentum balance over a volume element of dimensions Δx, Δy and Δz. [10]

6 A naphthalene ball of radius 'R' is kept in still air. The concentration of naphthalene in the air at the surface of the ball is C_{Ao}. Assume the concentration in the air at α is zero. Obtain concentration profile using equations of change. [15]

7 A semi-infinite body of liquid with constant density and viscosity is bounded on one side by a flat surface. Initially the solid and the fluid surface are at rest. At t = 0, the solid surface is set in motion in the positive x-direction with a velocity 'V'. Determine velocity as a function of position and time. [15]

8 a) Explain the following: (i) Reynolds stresses (ii) Wall turbulence. [6]

b) Explain the following theories: (i) Boussinesq's Eddy Viscosity (ii) Prandtl's Mixing length. [9]