Code No: **RT41081** **R13** **Set No. 1**

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

TRANSPORT PHENOMENA

(Chemical Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B

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PART–A *(22 Marks)*

1. a) Define viscosity & kinematic viscosity? [4]
   b) Explain the terms 'steady flow', 'laminar flow'? [3]
   c) What is the coefficient of volume expansion for an ideal gas? What is the corresponding expression for the Grashof Number? [3]
   d) Distinguish between Homogenous and Heterogeneous reactions. Which ones are described by boundary conditions and which ones manifest themselves in the differential equations? [4]
   e) Summarize all the steps required in obtaining the equation of change for the temperature. [4]
   f) How is the stream function defined, and why is it useful? [4]

PART–B *(3x16 = 48 Marks)*

2. a) What is diffusion? Explain the temperature & pressure dependence of mass diffusivity? [5]
   b) A substance has a temperature dependent thermal conductivity k (W/m^0C) $=0.45 + 8.1x10^{-4}T + bT^2$, where b $=6.2x10^{-7}$, and T is in ^0C. What is the unit of the coefficient b? Find the thermal conductivity of the material at 1050^0F. [11]

3. a) Obtain an expression for mass rate of flow **w** for an ideal gas in laminar flow in a long circular tube. The flow is presumed to be isothermal. Assume that the pressure change through the tube is not very large, so that the viscosity can be constant. [10]
   b) Water at 20^0C is flowing down a vertical wall with Re = 10. Calculate a) the flow rate, in gallons per hour per foot of wall length b) the film thickness in inches. [6]

4. a) Derive the relevant equations for 'free convection' when there is a heat flow between two parallel walls maintained at different temperatures? [10]
   b) Write about shell energy balances and boundary conditions? [6]

5. Derive the equation for 'diffusion and chemical reaction inside a porous catalyst". [16]

6. a) Flow between coaxial cylinders and concentric spheres. The space between two coaxial cylinders is filled with an incompressible fluid at constant temperature. The radii of the inner and outer wetted surfaces are kR and R, respectively. The angular velocities of rotation of the inner and outer cylinders are Ω_i and Ω_o. Determine the velocity distribution in the fluid and the torques on the two cylinders needed to maintain the motion. [12]

b) What factors would need to be taken into account in designing a mixing tank for use on the moon by using data from a similar tank on earth? [4]

7. a) An iron sphere of 1-in. diameter has the following physical properties: k = 30 Btu/hr·ft·F, $\hat{C}_p$ = 0.12 Btu/lb_m·F. and ρ = 436 lb_m/ft^3. Initially the sphere is at temperature of 70^0F. 8 arks
   (i) What is the thermal diffusivity of the sphere?
   (ii) If the sphere is suddenly plunged into a large body of fluid of temperature 270^0F, how much time is needed for the center of the sphere to attain a temperature of 128^0F. [8]

   b) A slab occupying the space between y=-b and y=+b is initially at temperature T_0.At time t=0 the surfaces at y= ±b are suddenly raised to T_1 and maintained there. Find T(y,t). [8]