BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION)

CLASS: BE **SEMESTER: IV**
BRANCH: CHEMICAL ENGG **SESSION : SP/2019**

SUBJECT : CL4007 TRANSPORT PHENOMENA

TIME: 1.5 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 30.
2. Candidates may attempt for all 30 marks.
3. In those cases where the marks obtained exceed 25 marks, the excess will be ignored.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. The missing data, if any, may be assumed suitably.

Q1 A fluid of constant density is flowing in laminar flow at steady state in the horizontal x direction between two flat and parallel plates. The distance between the two plates in the vertical y direction is $2y_0$. Derive the equation for the velocity profile within this fluid and the maximum velocity for a distance L m in the x direction. Using Navier – Stoke's equation. [6]

Q2 For a layer of liquid flowing in laminar flow in the z direction down a vertical plate or surface, derive the velocity profile. Where ð is the thickness of the layer, x is the distance from the free surface of the liquid toward the plate and v_z is the velocity at a distance x from the free surface. [6]

(i) What is the maximum velocity $v_{z,max}$?

Derive the expression for the average velocity $v_{z\,av}$ and also relate it to $v_{z,max.}$

Q3 Water in the bottom of narrow metal tube is held at constant temperature of 298K. The total pressure of air (assumed dry) is 1.01325×10^5 Pa and the temperature is 293K. Water evaporates and diffuses through the air in the tube and the diffusion path Z_2-Z_1 is 0.1524m long. Calculate the rate of evaporation at steady state in Kg mol/m^2. S. The diffusivity of water vapor at 293K and 1 atm pressure is 0.25×10^{-4} m^2/sec. Assume that the system is isothermal. [The vapor pressure of water 20°C is 17.54mm] [6]

Q4 Two bulbs are connected by a straight tube, 0.001 m in diameter and 0.15 m in length. Initially the bulb at End 1 contains N_2 and the bulb at End 2 contains H_2. Pressure and temperature are constant at 25 °C and 1 atm. At a time after diffusion starts, the nitrogen content of the gas at End 1 of the tube is 80 mol% and at End 2 is 25 mol%. If the binary diffusion coefficient is 0.784 cm^2/s, determine: [6]
(a) The rates and directions of mass transfer in mol/s
(b) The species velocities relative to stationary coordinates at End1 and End 2, in m/s
(c) molar average velocity at any point.

Q5 Briefly describe the following terms [6]
(i) Gradient;
(ii) Divergence;
(iii) Tensors;

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