Reg No.:_____ **00000CH401121902** Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech S7 (S) (PT) Exam Sept 2020

Course Code:CH401

Course Name: TRANSPORT PHENOMENA IN PROCESSES

Max. Marks: 100 Duration: 3 Hours

Use of Photostat copies of the complex equations of the following, duly attested by the concerned faculty of the institution shall be permitted in the University examination hall.

1. *Tables containing Equation of continuity and equation of motion in rectangular, cylindrical and spherical coordinate.*
2. *Tables containing Equations of the components of the stress tensor for Newtonian fluids in rectangular, cylindrical and spherical coordinate.*
3. *Tables containing Equation of energy in terms of momentum fluxes and transport properties in rectangular, cylindrical and spherical coordinate.*

PART A

Answer any two full questions, each carries 20 marks. Marks

1 a) Explain the concept of molecular theory of the viscosity of gases at low density. (10)

b) Compute the viscosity of CO_2 at 200K and 1 atm. Given Ω_μ =1.548, σ =3.996A°. (5)

c) Find the radius of a horizontal capillary of length 50 cm through which water flows at a mass flow rate of 2.997g/s. The pressure drop in the capillary is found to be 4.766 x 10^5 Pa. The kinematic viscosity of water may be taken as 4.03 x 10^{-5} m^2 /s. (5)

2 A cone and plate viscometer consists of a stationary flat plate and an inverted cone, whose apex just touches the centre of the plate. The liquid whose viscosity is to be measured is placed in the gap between the cone and plate. The cone is rotated at a known angular velocity Ω , and the torque Tz required to keep the cone rotating (at steady state) is measured. Find an expression for the viscosity of the fluid in terms of Ω, Tz and Ψ_0. For commercial instruments, Ψ_0 is very small about 1 degree. (15)

b) Consider an incompressible fluid, at constant temperature, flowin radially between two porous cylindrical shells with inner and outer radii kR and R.
(a) show that the equation of continuity leads to v_r = C/r, where C is a constant
(b) Simplify the components of the equation of motion. (5)

3 a) A Newtonian fluid is in laminar flow in a narrow slit formed by two parallel walls a distance 2B apart. Make a differential momentum balance and obtain expressions for the momentum flux and velocity distribution. What is the ratio of average to maximum velocity in that slit?. (10)

b) Using Navier-Stokes equation, derive an expression for (i) Velocity distribution; (ii) Maximum velocity; and (iii) Average velocity for the flow of an incompressible Newtonian fluid flows vertically downward through circular tube of radius R at steady state. (10)

PART B

Answer any two full questions, each carries 15 marks.

4 Determine the heat loss from a rectangular fin of length of 60 mm, width 0.30m and thickness 4mm to the ambient air having a temperature of 175°C. The heat transfer coefficient between the air and the fin surface is 680 $W/m^2.K$. The surface temperature of air is 260 °C. The thermal conductivity of the fin is 103W/m.K. Derive the equations that you use to solve the problem. (15)

5 Consider 2 concentric spherical shells of radii kR and R. The inner surface of the outer one is at $T=T_1$ and the outer surface of the inner one is to be maintained at a low temperature T_k. Dry air at temperature $T= T_k$ is blown outward radially from the inner shell into the intervening space and out through the outer shell. Develop an expression for the required rate of heat removal from the inner spheres as a function of the mass rate of flow of gas. Assume steady laminar flow and low gas velocity. (15)

6 a) Calculate the thermal conductivity of a gas mixture containing 20 mol% CO_2 and 80 mol% H_2 at 1 atm and 300K. Given (7)

	Thermal Conductivity (Cal/s.cm.K)	Viscosity(g/s.cm)
CO_2	$383x10^{-7}$	$1495x10^{-7}$
H_2	$4250x10^{-7}$	$896x10^{-7}$

b) Derive an expression for temperature distribution T(x) in a viscous fluid in steady laminar flow between large flat parallel plates kept 2B apart. Both plates are maintained at constant temperature T_0. Take in to account explicitly the heat generated by viscous heat dissipation. Neglect the temperature dependence of μ and k. (8)

PART C

Answer any two full questions, each carries 15 marks.

7 a) Explain various types of fluxes in mass transport with their representations. (5)

b) Explain kinetic theory of diffusion of gases at low density and explain its temperature and pressure dependency. (10)

8 An instantaneous dimerization reaction, $2A \rightarrow B$ is taking place on a catalyst surface. The effective gas film thickness on the catalyst surface may be taken as 'δ'. Using suitable assumptions, develop expressions for the concentration profile of the component A and the molar flux of A through the gas film. (15)

9 a) Calculate steady state mass flux of helium at 500°C. The partial pressure of helium is 1atm at lower end and zero at the upper surface of the plate. Thickness of the pyrex plate is 10^{-2} mm and its density is 2.6 g/cm^3. The solubility and diffusivity of helium in pyrex are reported as 0.0084 volume of gaseous helium per volume of glass and $0.2x10^{-7}$ cm^2/s respectively. (7)

b) Derive equation of continuity for binary mixture in terms of mass units. (8)

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