Reg No.:_____ **00000CH40112190I** Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree Examination (Regular and Supplementary), December 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 Marks

Answer any two full questions, each carries 20 marks

1 a) Compute the mean molecular velocity of $\bar{\upsilon}$(in cm/s) and the mean free path λ (in cm) for oxygen at 1atm and 273.2K.A reasonable value for d is $3A^0$.What is the ratio of the mean free path to the molecular diameter under these conditions? (5)

b) Two immiscible incompressible fluids are flowing in the 'z' direction in a horizontal thin slit of length L and width W under the influence of pressure gradient. Derive the expressions for shear stress and velocity distribution. (15)

2 a) Using the equation of continuity, show that $\nabla v = 0$. (5)

b) Derive the equation of motion in rectangular co-ordinate system and also deduce the expression to Euler's equation for a constant density and viscous system. (15)

3 a) By setting up a shell momentum balance, derive the expressions for velocity profile, maximum velocity, average velocity and volumetric flow rate for the flow of an incompressible Newtonian fluid flowing down as a film over an inclined rectangular plane of length 'L' and width 'W. The surface of the plane is inclined at an angle 'β' with the vertical and 'δ' is the thickness of the film. (13)

b) Explain with a neat figure, the velocity distribution for turbulent flow in tubes. (7)

PART B

Answer any two full questions, each carries 15 marks.

4 Consider a spherical form of nuclear fissionable material of radius R^F and is surrounded by aluminium cladding of radius R^C .The purpose of cladding is to absorb neutrons. Inside the fuel element, due to fission thermal energy is produced (S_n).This source will not be uniform throughout the sphere of fissionable material, it will be smallest at the centre of the sphere. Therefore source is assumed as a parabolic function. $Sn = Sn_0 [1+b(r/ R^F)^2]$, where Sn_0 is the volume rate of production at the centre of the sphere, b-dimensionless (15)

constant. Derive the expression for temperature distribution in the aluminium cladding and fissionable material.

5 A liquid is flowing downward in steady laminar flow along an inclined plane surface. The free liquid surface is maintained at temperature T_0 and the solid surface at $x=\delta$ is maintained at T_δ. At these temperatures the liquid viscosity has values μ_0 and μ_δ respectively and the liquid density and thermal conductivity may be assumed constant. Find the velocity distribution in this nonisothermal flow system, neglecting end effects and recognizing that viscous heating is unimportant in this flow. Assume that the temperature dependence of viscosity may be expressed by an equation of the form, $\mu = Ae^{B/T}$, with A& B being empirical constant. (15)

6 a) Heat is flowing through an annular wall of inside radius r_0 and outside radius r_1. The thermal conductivity varies linearly with temperature from k_0 at T_0 to k_1 at T_1. Develop an expression for the heat flow through the wall. (10)

b) Write the vector form of the equation of energy and explain the significance of the terms involved in it. (5)

PART C

Answer any two full questions, each carries 15 marks.

7 a) Explain the flowing, (10)

(i)Types of diffusion (ii) Concentrations (iii) Diffusion velocities (iv) Fluxes

b) Estimate the diffusivity for a dilute aqueous solution of acetic acid at 12.5°C, using the Wile-Chang equation. The viscosity of the solution is 1.22 cp and molar volume of the solute is 64.1 cm^3/gmol. The association parameter for water is 2.6. (5)

8 a) Discuss the analogies between heat, mass and momentum transfer. (5)

b) Develop a concentration profile for the diffusion of liquid A in a diffusion apparatus into stagnant gas B. Make suitable assumptions. (10)

9 a) Discuss the concept of mass diffusivity and explain the effect of temperature and pressure on mass diffusivity. (5)

b) In studying the rate of leaching of substances A from solid particles by a solvent B. We may postulate that the rate controlling step is the diffusion of A from the particle surface through a stagnant liquid film thickness ‘δ’ out in to the main stream. The molar solubility of A in B is C_{A0} and the concentration in the main stream is $C_{A\delta}$. (10)

(a) Obtain a differential equation for C_A as a function of ‘z’ by making a mass balance on ‘A’ over a thin slab of thickness Δz. Assume that D_{AB} is constant and no convective transport. Neglect the curvature of the particle.

(b) Show that in the absence of chemical reaction in the liquid phase, the concentration profile is linear.

(c) Find the rate of leaching.

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