Gandhi Institute of Engineering and Technology University, Odisha, Gunupur (GIET University)

B. Tech (Fifth Semester - Regular) Examinations, November – 2024

22BCHPC35003 – Transport Phenomenon

(Chemical Engineering)

Time: 3 hrs Maximum: 70 Marks

Answer ALL questions

(The figures in the right hand margin indicate marks)

PART – A **(2 x 5 = 10 Marks)**

Q.1. Answer ***ALL*** questions

	Question	CO #	Blooms Level
a.	Write the shell momentum balance equation.	CO1	K1
b.	Define thermal diffusivity.	CO1	K1
c.	Thermal conductivity varies with temperature linearly. At $T=T_0$, $K= K_0$ and at $T=T_1$, $K=K_1$. Write the equation relating K and T.	CO2	K2
d.	State the boundary conditions used for solving shell mass balance equations.	CO2	K1
e.	Define degree of turbulence.	CO3	K1

PART – B **(15 x 4 = 60 Marks)**

Answer ***All*** the questions

	Question	Marks	CO #	Blooms Level
2. a.	Derive an expression for velocity profile when a Bingham fluid is flowing through a pipe of radius R vertically downward.	10	CO1	K2
b.	Explain types of fluids with representation on shear stress and shear strain plot.	5	CO1	K1
	(OR)			
c.	Derive an expression for average velocity of Newtonian fluid flow between two vertical walls, separated by a distance 2B. Taking origin at midpoint of 2B distance, develop the expression from shell momentum balance equation.	10	CO1	K2
d.	Derive an expression for velocity profile when a Newtonian fluid is flowing through a pipe of radius R horizontally.	5	CO1	K2
3.a.	A heated sphere of radius R suspended in a large motionless body of fluid. Show that, $Nu = \frac{hD}{K} = 2$. Where h is heat transfer coefficient, D is the diameter of sphere and K is the thermal conductivity.	10	CO2	K2
b.	State Newton's law of viscosity. In what way are Newton's law of viscosity and Fourier's law of heat conduction similar and dissimilar?	5	CO2	K1
	(OR)			
c.	How is binary diffusivity and self-diffusion defined? Give typical orders of magnitude of diffusivity of gases, liquids and solids.	15	CO2	K1
4.a.	A hollow solid sphere has its inner radius ($r = R_1$) and outer radius ($r = R_2$) maintained at concentrations C_{A1} and C_{A2} respectively. Obtain the concentration profile in the solid at steady-state condition.	10	CO3	K2
b.	Explain Free and Forced convection	5	CO3	K1
	(OR)			
c.	Consider a long cylindrical nuclear fuel rod, surrounded by an annular layer of aluminium cladding. Within the fuel rod heat is produced by fission; this heat	15	CO3	K2

source depends on position approximately as, $S_n = S_{no} \times r^2$, where $S_{n0}$is known constants, and r is the radial coordinate measured from the axis of the cylindrical fuel rod. R_F and R_C are the radius of fission and cladding materials.
Derive an expression for temperature profile in the cladding material if the temperature at the outer surface of cladding is T0 .

5.a.	Explain Prandtl mixing length concept in turbulent flow.	10	CO4	K1
b.	Derive the formula for Fanning's friction factor.	5	CO4	K2
	(OR)			
c.	Derive the dimensionless shell energy balance differential equation in turbulent pipe flow and mention the boundary conditions.	15	CO4	K1

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