U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

July 2024 Semester End Main Examinations

Programme: B.E. **Semester: V**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 22CH5PCTRP **Max Marks: 100**
Course: Transport Phenomena

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			UNIT - I	CO	PO	Marks
1	a)		What are the transport properties that appear for heat, mass, and momentum transfer equations? Express these units in SI system.	*CO1*	*PO11*	**06**
	b)		The lower plate is being pulled at a relative velocity of 0.4 m/s greater than top plate. The fluid is at 24°C temperature and viscosity 0.4×10^{-2} Ns/m^2. (i) How far apart should the two plates be placed so that the shear stress, $\tau_{yx} = 0.3\,\text{N/m}^2$? and (ii) What is τ_{yx} and shear rate, if oil viscosity is 2×10^{-2} N s/m^2?	*CO2*	*PO2*	**08**
	c)		Calculate the heat loss per square meter of surface area for an insulating wall composed of 25.4 mm thick fiber insulating board, where the inside temperature is 352.7K and outside temperature is 297.1K. The thermal conductivity of the insulating board is 0.048 W/mK.	*CO2*	*PO2*	**06**
			UNIT - II			
2	a)		Derive a relation for falling liquid on a flat surface inclined with an angle ϕ using momentum shell balance. Show that the average velocity is given as $<\upsilon_z>=\frac{\rho g\delta^2\cos\phi}{3\mu}$	*CO3*	*PO4*	**10**
	b)		A 20kg, 25 mm diameter, 30 cm tall cylindrical tank slides down a ramp coated with oil at a constant speed of 3 cm/sec. The uniform thickness of oil layer on the ramp has a viscosity of 1kg sec/m^2. Determine the angle of inclination of the ramp.	CO2	PO2	**10**

			OR			
	3	a)	Derive the velocity profile for Non-Newtonian fluid flowing on top of an inclined flat plate at an angle of α with vertical. The Non-Newtonian obeys $\tau = \mu\left(\frac{dv}{dx}\right)^n$	***CO3***	***PO4***	**10**
		b)	A Newtonian fluid is contained in a space between two parallel plates 6cm apart the top plate is moving at a velocity of 25 cm/min and the bottom plate is moving at 80cm/min in the opposite direction. The viscosity of the fluid is 1.5poise. Applying shell momentum balance, derive an expression for velocity. Calculate the steady state velocity at 1cm interval and plot the same.	***CO2***	***PO2***	**10**
			UNIT - III			
	4	a)	Determine the heat flux and overall heat transfer coefficient for a composite wall of three materials with thermal conductivity of k_1, k_2, k_3 respectively and located between two fluid streams at temperatures T_1 and T_2.	***CO3***	***PO4***	**06**
		b)	A 100 W bulb is buried in soil(k=0.84/mK) and burnt until a steady state is reached. Estimate the temperature of the soil at 30cm away from the buried bulb. Assume the bulb is of spherical body.	***CO2***	***PO2***	**06**
		c)	A furnace wall is exposed to hot flue gases at 1100 K. The wall consists of 0.12 m of fire brick and 0.25 of common brick. Heat transfer coefficient on the hot side is 3000 W/m^2K & 22W/m^2K on the outside. Ambient air is at 300K. Calculate the heat transfer rate per m^2 of wall and temperature at the interface of the two bricks. The thermal conductivity of the both the bricks is 0.138 W/m K.	***CO3***	***PO4***	**08**
			OR			
	5	a)	Derive the equations for temperature profile and heat flow at the surface for heat condition with electric source.	***CO3***	***PO4***	**12**
		b)	A tungsten wire has a radius of 2 mm and a length of 5 m. For what voltage drop would the temperature at the wire axis be	***CO3***	***PO4***	**08**

			10°C, if the surface temperature of the wire is 20°C? Data: Lorenz number for tungsten = 3.60×10^{-8} volt^2/K^2.			
			UNIT- IV			
	6	a)	Determine the expression for flux for a liquid A diffusing through a stagnant gas B.	***CO4***	***PO3***	**10**
		b)	Cholropicric (CCl_3NO_2) is kept in a Arnold cell and the liquid is evaporating in the stagnant air at 25°C. Determine the rate of evaporation in kg/h from the following data Total pressure= 770 mm Hg ; Diffusivity=8.8×10^{-6} m^2/s; Vapor pressure= 23.8 mm Hg ;Distance of liquid level to the top of the tube= 11.14 cm; Molecular weight = 164.35 ; Density of CCl_3NO_2 = 1650 g/cc; Surface area of the liquid exposed for evaporating = 2.29cm^2	***CO4***	***PO4***	**10**
			UNIT - V			
	7	a)	Briefly explain the Reynolds analogy.	***CO6***	***PO2***	**05**
		b)	Write the Navier-stokes equation and Euler equation. For what type of fluid/flow are these equations applicable?	***CO6***	***PO2***	**05**
		c)	Derive equation of motion in terms of shear stress and velocity with a neat sketch.	***CO5***	***PO3***	**10**

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