U.S.N.										

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

Autonomous Institute Affiliated to VTU

September / October 2024 Supplementary 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)	If the velocity distribution for a fluid over a plate is given by $v_z = \frac{2}{3}y - y^2$ Where, v_z is the velocity in m/s at a distance y meter above the plate, determine the shear stress at y = 0 and y = 0.15 m. The dynamic viscosity of the fluid is 8.63 P.	*CO1*	*PO11*	**10**
	b)	State the Newton's law of viscosity, Fourier's law of heat conduction, and Fick's law of diffusivity with equations.	*CO1*	*PO11*	**06**
	c)	What do you understand by transport phenomena? What are the three levels at which transport phenomena can be studied?	*CO1*	*PO11*	**04**
		UNIT - II			
2	a)	An aqueous homogenous solution of two polymers is pumped through an annulus at 293 K. The horizontal annulus of 8.23 m long, the outside radius of the inner cylinder is 1.25 cm. The inside radius of the outer cylinder is 2.794 cm. The density is 1287 kg/m^3 and viscosity is 566 $\times 10^{-4}$ Pa s at 293 K. Calculate the volumetric flow rate when the impressed pressure drop is 37.164 kN/m^2.	*CO2*	*PO2*	**08**
	b)	Derive an expression for maximum velocity and mass flow rate for flow of liquid over an inclined plane which is at an angle β with the vertical axis.	*CO3*	*PO4*	**12**
		OR			
3	a)	Oil is flowing in a laminar region in a 1.27×10^{-2} m diameter tube at the rate of 22.72 l/min. The oil viscosity is 250×10^{-3} N s/m^2 and its density is 958 kg/m^3. Calculate (a) The pressure drop per meter of the pipe length and (b) Wall stress in N/m^2 (c) The velocity at the center of the tube and (d) Radial position at which the velocity is equal to the average velocity	*CO2*	*PO2*	**08**

		b)	A Newtonian fluid is flowing through a circular vertical tube, due to pressure difference, of length *L* and radius *R*. Derive an expression for shear stress and the velocity distribution in the tube. Draw the velocity distribution in the tube.	***CO3***	***PO4***	**12**
			UNIT - III			
	4	a)	A copper wire has a diameter of 3 mm and a length of 5 m. For what voltage drop would the temperature at the wire axis be 10°C, if the surface temperature of the wire is 20°C? Data: Lorenz number of copper = $k/(k_e T_0) = 2.23\times10^{-8}$ volt^2/K^2.	***CO3***	***PO4***	**08**
		b)	Derive an equation that relates the average temperature and the maximum temperature for heat conduction with an electrical source of heat.	***CO3***	***PO4***	**12**
			OR			
	5	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***	**10**
		b)	Heat is generated within a sphere at a rate of 20×10^5 kW/m^3. The diameter of the sphere is 0.163 m. The surface temperature of sphere is 100°C. The thermal conductivity of the metal of the sphere is 1400 W/m°C. Calculate the temperature at the center of the sphere and at radius of 0.04 m.	***CO3***	***PO4***	**10**
			UNIT - IV			
	6	a)	Gas 'A' dissolves in liquid 'B' in a beaker and diffuses isothermally into the liquid phase. As it diffuses, 'A' also undergoes an irreversible first order homogeneous reaction, A + B → AB. Rate of reaction is given by, $-r_A = k_1''' c_A$, where k_1''' is first order rate constant based on volume (1/s). Derive an equation to determine the concentration distribution and molar flux and list all the assumptions made.	***CO4***	***PO3***	**14**
		b)	The diffusivity of methanol in air is determined by observing the steady state evaporation of CH_3OH into a tube containing air. The distance between the methanol liquid level and the top of the tube is 16cm. The pressure and temperature are 1 atm and 298 K. The vapour pressure of methanol at 298 K is 17 kPa and its specific gravity is 0.7914. The cross sectional area of the tube is 0.8 cm^2. It is found that 0.0887 cc of methanol evaporates in a 10 h period after steady state has been attained. Estimate the diffusivity of methanol-air system.	***CO4***	***PO3***	**06**
			UNIT - V			
	7	a)	Derive the Navier-Stokes equations from basics for Cartesian coordinates.	***CO6***	***PO6***	**14**
		b)	Briefly explain Prandtl Anaology.	***CO6***	***PO6***	**06**

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