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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**

Branch: Chemical Engineering **Duration: 3 hrs.**

Course Code: 23CH5PCTRP / 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? Explain with equations.	*CO1*	*PO1*	**12**
	b		If the distance between two plates is 0.5 cm, the velocity gradient is 10 cm/s and the fluid between the plates is ethanol at 273 K having a dynamic viscosity of 1.77cP, determine the shear stress and shear rate.	*CO1*	*PO1*	**08**
			OR			
2	a)		State Newton's Law of viscosity and discuss any three models to describe Non-Newtonian fluids. Give the equation with its unit	*CO1*	*PO1*	**06**
	b)		Calculate the rate of heat transfer per unit area through a copper plate 45mm thick, one face of which is maintained at 350°C and the other face at 50°C. The thermal conductivity is 370 W/m °C.	*CO1*	*PO1*	**08**
	c)		What are thixotropic and rheopectic fluids? Give examples.	*CO1*	*PO1*	**06**
			UNIT - II			
3	a)		A fluid that is nearly described by the Bingham model, is flowing through a vertical pipe section, as a result of the pressure gradient and gravitational acceleration. The radius and the length of the pipe are R and L, respectively. Derive the relation between the volume rate of flow, Q and the combined pressure and gravity forces acting on the fluid.	*CO2*	*PO2*	**10**
	b)		The lower plate is being pulled at a relative velocity of 0.5 m/s greater than top plate. The thermal oil fluid between the plates is at 24°C and of viscosity 0.5×10^{-2} Ns/m^2. Calculate: (i) How far apart should the two plates be placed so that the shear stress, $\tau_{yx} = 0.3$N/m^2? (ii) What is $\tau_{yx}$and shear rate, if oil viscosity is 6×10^{-2} Ns/m^2?	*CO2*	*PO2*	**10**

			OR			
	4	a)	Determine the relation between the average velocity and maximum velocity for flow of Newtonian fluid through an annulus between a pipe of radius of R and another of κ R. The step-by-step derivation with schematic is essential.	*CO2*	*PO2*	**14**
		b)	Newtonian fluid is pumped through a horizontal annulus at 30 °C and 10 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 fluid density is 900 kg/m^3 and viscosity is 500×10^{-4} Ns/m^2 at 30°C. Calculate the volumetric flow rate, when the impressed pressure drop is 37,164 N/m^2.	*CO2*	*PO2*	**06**
			UNIT - III			
	5	a)	An electric wire of circular cross section with radius R is conducting electricity. The rate of head production per unit volume is given by $S_e = \frac{I^2}{k_e}$, where, k_e is the electrical conductivity (Ohm per cm), I is current density in Amp/cm^2. S_e which is the heat source due to electrical dissipation. Determine the temperature profile for such a situation as a function of radius.	*CO3*	*PO4*	**12**
		b)	An electric current of 1000 Amps is passed through a copper wire of radius of 1.26 mm and length of 91 cm. The wire has resistance of 0.126 Ohms. The outer surface temperature is held at 422.1 K. The average thermal conductivity is 22.5 W/mK. Calculate the centerline temperature.	*CO3*	*PO4*	**08**
			OR			
	6	a)	Determine the overall heat transfer coefficient for a composite spherical wall of three materials with thermal conductivity of k_1, k_2, and k_3 respectively, and located between two fluid streams at temperature T_1 and T_2.	*CO3*	*PO4*	**10**
		b)	Polyurethane foam and expanded polystyrene are two important insulations for low temperature applications. Polyurethane can be impregnated with a flame retardant and is probably safer. The tank is insulated with a 10 cm thick layer of polyurethane foam having a thermal conductivity of 0.02 W/m °C. The outer surface of the Horton sphere (a spherical vessel used for cryogenic storage) is 27°C. Calculate the heat gain by a Horton sphere of 16 m diameter that contains liquid ammonia at 4°C. Calculate the refrigerant required for the vessel. Note: One ton of refrigeration absorbs 3.516 kW of energy.	*CO3*	*PO4*	**10**
			UNIT - IV			
	7	a)	Determine the expression for flux of a gas A diffusing through a stagnant gas B.	*CO4*	*PO3*	**10**

		b)	A well located in a desert is 2 m in diameter and has water at a level 10 m deep. The stagnant air & water in the well are at 32°C and 1 atmosphere pressure. A wind of dry air is blowing across the top of the well. Calculate the rate in kg/h of diffusion at steady state of the water vapor from the surface of the well. Data: Partial pressure of water (p_A): 4.868 kN/m^2 Diffusivity in water in air ($\mathscr{D}_{AB}$)= 25.6 mm^2/sec at 25°C	*CO4*	*PO3*	**10**
			OR			
	8	a)	Determine the expression for flux for diffusion from a spherical rain droplet into a quiescent air.	*CO5*	*PO3*	**10**
		b)	A mixture of benzene and toluene is distilled in a mass transfer laboratory unit at one plane in a vertical tube. The vapor contains 85.3 mole % benzene and at the adjacent liquid film contains 70 mole% benzene at the temperature of 87°C. The gas layer between is assumed to be stagnant and 0.254cm thick. The molar latent heats of vaporization of benzene and toluene are same implying equimolar counter diffusion. The vapor pressure of toluene at 87°C. is given as 368mmHg. Calculate the rate of interchange of benzene and toluene between the vapor and liquid. The diffusion coefficient of benzene toluene vapor is 5.06×10^{-6} m^2/s.	*CO4*	*PO3*	**10**
			UNIT - V			
	9	a)	Briefly explain the Reynolds analogy and Colburn Chilton analogy.	*CO6*	*PO2*	**08**
		b)	Derive equation of motion in terms of shear stress and velocity using Cartesian coordinates. State all the assumptions.	*CO5*	*PO3*	**12**
			OR			
	10	a)	Briefly explain the J factor analogy and its importance.	*CO6*	*PO2*	**08**
		b)	Write the Navier Stoke's equation & Euler's Equation. Discuss their significance.	*CO6*	*PO2*	**06**
		b)	Explain the cylindrical coordinate system with a neat sketch.	*CO5*	*PO3*	**06**

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