U.S.N.										

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

Autonomous Institute Affiliated to VTU

January / February 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)		State and explain Fourier's law of heat conduction.	*CO1*	*PO1*	**06**
	b)		Discuss the various non-Newtonian fluids with the corresponding rheological equations.	*CO1*	*PO1*	**06**
	c)		The lower plate is being pulled at a relative velocity of 0.4 m/s greater than the top plate the fluid used is at 24°C, viscosity is 0.4×10^{-2} N.s/m^2. How far apart the should the two plates be placed so that the shear stress is 0.3 N/m^2 (N). If the oil viscosity = 0.4×10^{-2} N.s/m^2 used and plates are kept separated at a distance calculated in part a and the velocity is same as part a what is the shear stress and shear rate	*CO 1*	*PO11*	**08**
			OR			
2	a)		What are thixotropic and rheopectic fluids? Give examples.	*CO1*	*PO1*	**08**
	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)		Explain Fick's law of diffusion.	*CO1*	*PO1*	**04**
			UNIT - II			
3	a)		A Newtonian fluid of constant μ and ρ is in laminar flow in a circular tube of radius R. Make a differential momentum balance and obtain the expressions of momentum flux and velocity distributions for (i) Newtonian fluid (ii) Bingham fluid	*CO2*	*PO2*	**13**
	b)		Determine the pressure gradient and the shear stress at the two horizontal parallel plates 100 mm apart. the maximum velocity for	*CO2*	*PO2*	**07**

			the laminar flow of oil is 2 m/s. Given viscosity is 2 Pas. Determine also the discharge /meter width.			
			OR			
	4	a)	A fluid with constant viscosity and density flows along an inclined flat surface under the influence of gravity. Derive the equation for momentum flux distribution and velocity distribution for a Newtonian fluid. Write all the assumptions. i. The film thickness is measured from the wall. ii. The film thickness is measured from the liquid surface.	*CO2*	*PO2*	**12**
		b)	Find the radius of capillary tube from the following flow data • Length of the tube =50 cm. • Kinematic viscosity = 4×10^{-5} m^2/s. • Density of liquid= 700 kg/m^3. • Pressure drop in horizontal tube = 6×10^{5} Pa. • Mass flow rate = 5×10^{-3} kg/s.	*CO2*	*PO2*	**08**
			UNIT - III			
	5	a)	Consider a nuclear fuel element of spherical form. It consists of a sphere of fissionable material with radius R_F surrounded by a spherical aluminum cladding with outer radius R_C. Derive expression for heat flux profile in fissionable material and cladding.	*CO 3*	*PO4*	**10**
		b)	Derive an expression for heat flow through a solid sphere with internal heat generation. Prove that for heat transfer by conduction from a sphere of diameter D to a stagnant infinite fluid medium Nu=2	*CO 3*	*PO4*	**10**
			OR			
	6	a)	Derive the equation for heat conduction through a composite wall.	*CO3*	*PO4*	**07**
		b)	Derive an expression for energy flux distribution, temperature distribution, and maximum temperature rise for heat conduction with an electrical heat source.	*CO3*	*PO4*	**13**
			UNIT – IV			
	7	a)	Derive an expression for rate of sublimation of iodine sphere in still air.	*CO4*	*PO3*	**07**
		b)	Gas A dissolves in liquid B and diffuses into the liquid phase. A undergoes an irreversible first order chemical reaction A+B→ AB. Find concentration profile of A in B. Also find molar flux.	*CO4*	*PO3*	**13**
			OR			
	8	a)	Oxygen is diffusing in a mixture of oxygen-nitrogen at 1 std atm, 25˚C. Concentration of oxygen at planes 2 mm apart are 10 and 20 volume % respectively. Nitrogen is non-diffusing.	*CO4*	*PO3*	**07**

			i. Derive the appropriate expression to calculate the flux oxygen. ii. Calculate the flux of oxygen. Diffusivity of oxygen in nitrogen = 1.89×10^{-5} m^2/sec.			
		b)	Consider a catalytic reactor in which a gaseous reactant A diffuse through a stagnant gas film to reach the catalyst surface. At the catalyst surface, the reaction occurs instantaneously and product B diffuses back out through the gas film to the main turbulent stream. Derive an expression for variation of mole fraction of component A with Z, if the reaction is $2A \rightarrow B$.	*CO4*	*PO3*	**13**
			UNIT – V			
	9	a)	Derive equation of motion in terms of shear stress and velocity using Cartesian coordinates. State all the assumptions.	*CO5*	*PO3*	**12**
		b)	Explain the term partial time derivative and substantial time derivative with example.	*CO5*	*PO3*	**08**
			OR			
	10	a)	Discuss Reynold's analogy between momentum, heat and mass transfer.	*CO 6*	*PO2*	**10**
		b)	Derive equation of continuity in terms of shear stress and velocity using Cartesian coordinates. State all the assumptions.	*CO5*	*PO3*	**10**

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