P P SAVANI UNIVERSITY

Seventh Semester of B. Tech. Examination

November 2022

SECH 4062 Transport Phenomena

05.12.2022, Monday **Time: 10:00a.m. To 12:30 p.m.** **Maximum Marks: 60**

Instructions:

1. The question paper comprises of two sections.
2. Section I and II must be attempted in separate answer sheets.
3. Make suitable assumptions and draw neat figures wherever required.
4. Use of scientific calculator is allowed.

SECTION – I

Q - 1	MCQ/Short Question/Fill in the Blanks (Any Five)	**[05]**	**CO**	**BTL**
(i)	Convert 24°C to °F		**1**	**1**
(ii)	Write equation of Reynolds number.		**2**	**2**
(iii)	Write equation of Ellis Model.		**2**	**1**
(iv)	Write basic equation for steady state heat conduction (Fourier's law)		**2**	**1**
(v)	Convert 1 bar to N/m^2.		**1**	**2**
(vi)	Write equation of Motion.		**5**	**1**
(vii)	Write differential equation of continuity.		**2**	**2**
Q - 2 (a)	State driving force and resistance for each transport phenomena.	**[05]**	**5**	**2**
Q - 2 (b)	There are two parallel plates some distance apart. Between the plates, water is used at 24°C. The lower plate is being pulled at a constant velocity 0.4 m/s faster relative to the top plate. How far apart should the two plates be placed so that the shear stress x is 0.3 N/m^2? Also calculate the shear rate. $\mu = 0.9142*10^{-3}$ kg/m.s	**[05]**	**3**	**5**

OR

Q - 2 (a)	Derive an expression for Reynolds Analogy for momentum and heat transfer.	**[05]**	**2**	**2**
Q - 2 (b)	Oil is manufactured by the vapour phase catalytic reaction. The reaction gas mixture leaving the catalytic reactor in the plant is condensed in a shell-and-tube heat exchanger. The condensation occurs on the shell side while the cooling water flows through the tubes. The tubes are 3m long and 25 mm outside diameter, 14 BWG (Birmingham Wire Gauge). Water flows at a rate of 0.057 m^3/min per tube. Water enters at 32°C. The tube wall temperature may be assumed to be constant at 80°C. Calculate the heat transfer coefficient by the Reynolds analogy. Properties of water: Density, ρ = 995 Kg/m3 Viscosity, $\mu = 7.65*10^{-4}$ kg/m.s Thermal conductivity, k = 0.623 W/m · C Specific heat, $Cp = 4.17*10^{-3}$ J/Kg · C The Fanning friction factor f can be calculated by the equation, $f = 0.0014 + \frac{0.125}{(N_{Re})^{0.32}}$	**[05]**	**3**	**5**
Q - 3 (a)	Derive derivation of laminar flow in a narrow slit.	**[05]**	**3**	**1**
Q - 3 (b)	Explain the newton's law of viscosity.	**[05]**	**2**	**2**

	OR			
Q - 3 (a)	Explain the diagram in detail for Newtonian and time-independent Non-Newtonian fluids.	**[05]**	**2**	**2**
Q - 3 (b)	What is Boundary layer? Explain Boundary layer separation and formation of wakes.	**[05]**	**3**	**2**
Q - 4	Attempt any one/two.	**[05]**		
(i)	Derive the derivation of flow through a circular Tube (Gravity Flow)		**3**	**1**
(ii)	Explain in detail Newtonian and Non-Newtonian fluid.		**2**	**1**
	SECTION – II			
Q - 1	MCQ/Short Question/Fill in the Blanks (Any Five)	**[05]**		
(i)	Here are some assumptions that are made for Fourier law. Identify the wrong one a) No internal heat generation b) Steady state heat conduction c) Non- linear temperature profile d) Isotropic and homogenous material		**2**	**2**
(ii)	"Thermal conductivity represents the amount of heat conducted across the unit area when a temperature difference of one kelvin". a) True b) False		**1**	**2**
(iii)	Mark the matter with least value of thermal conductivity a) Air b) Water c) Ash d) Window glass		**2**	**1**
(iv)	The heat energy propagation due to conduction heat transfer will be minimum for a) Lead b) Water c) Air d) Copper		**2**	**2**
(v)	The relationship between the thermal and hydrodynamic boundary layer thicknesses governed by the a) Peclet number b) Prandtl number c) Stanton number d) Fourier number		**2**	**2**
(vi)	What is the unit of diffusion coefficient? a) m2 b) s c) m2s d) m2/s		**2**	**2**
(vii)	For what kind of mixtures DAB=DBA holds? a) Ideal b) Real c) For both real and ideal d) This relation is never true.		**5**	**1**
Q - 2 (a)	What is Boundary layer? Explain Boundary layer separation and formation of wakes.	**[05]**	**2**	**2**
Q - 2 (b)	Estimate the diffusion coefficient for acetic acid in dilute aqueous solution at 12.5^{0}C. M_A =60, M_B =18, μ =1.496 cp, ψ_B =1, ρ_{acid} = 0.937 g/cm^3.	**[05]**	**3**	**5**

OR

Q - 2 (a)	Derive the time smoothing the energy equation.	**[05]**	**5**	**2**
Q - 2 (b)	Predict D_{AB} for the methane-ethane system at 203 ^{0}F and 1 atm., using the Chapman-Enskog theory. Data:- $M_A = 16.04$, $\sigma_A = 3.924^0$A, $\epsilon_A/k = 137^0$K $M_B = 30.07$, $\sigma_B = 4.127^0$A, $\epsilon_B/k = 230^0$K	**[05]**	**3**	**5**
Q - 3 (a)	State driving force and resistance for each transport phenomena.	**[05]**	**4**	**4**
Q - 3 (b)	A plastic panel of area A=729 cm^2 and thickness Y=0.35 cm was found to conduct heat at a rate of 2.7 watts at steady state with temperature of initial temperature = 30^{o}C and final temperature =35 ^{o}C on the two main surfaces. Find out the thermal conductivity?	**[05]**	**5**	**5**

OR

Q - 3 (a)	Explain Fourier's law of Heat conduction and state the difference between analogy between heat and momentum transfer.	**[05]**	**5**	**4**
Q - 3 (b)	A plastic panel of area A = 1 ft^2 and thickness Y = 0.252 in. was found to conduct heat at a rate of 3.0 W at steady state with temperatures T_o = 24^{0}C and T_1, = 26^{0}C imposed on the two main surfaces. What is the thermal conductivity of the plastic in cal/cm. s K at 25^{o}C?	**[05]**	**5**	**5**
Q - 4	Attempt any one/two.	**[05]**		
(i)	Derive the derivation of flow through a circular Tube (Gravity Flow).		**4**	**2**
(ii)	Derive the expression for laminar flow in a narrow slit.		**2**	**4**

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CO : Course Outcome Number BTL : Blooms Taxonomy Level

Level of Bloom's Revised Taxonomy in Assessment

1: Remember	2: Understand	3: Apply
4: Analyze	5: Evaluate	6: Create