Q. Code:289001

Reg. No. | | | | | | | | | | | | | | |

M.E./ M. TECH DEGREE EXAMINATIONS, MAY 2024

Second Semester

CL22201-ADVANCED TRANSPORT PHENOMENA

(Chemical Engineering)

(Regulation 2022)

Time: 3Hours **Max.Marks: 100**

CO1	Remember and apply the fundamental knowledge involving Equations of Change for Isothermal systems.
CO2	Acquire and apply the fundamental knowledge involving Equations of Change for Non – Isothermal systems.
CO3	Gain and apply the fundamental knowledge for estimating the concentration distributions among different scenarios.
CO4	Practice the skill of preparing model in macroscopic scale for Isothermal and Non – Isothermal systems.
CO5	Analyze and/or construct the macroscopic model for any Multi Component systems.

PART- A (20x2=40Marks)

(Answer all Questions)

		CO	RBT LEVEL
1	Write the dimensionless form of equation of continuity.	1	2
2	Summarize the law of conservation of energy statement for non-isothermal system.	1	2
3	Write in your own words the conservation of momentum principle.	1	2
4	List the two observations you arrive while writing equation of continuity for incompressible flow.	1	2
5	Justify the use of Boussinesq approximation for analysing free convection problems.	2	4
6	Write the fourier number with its applications.	2	4
7	Give the mathematical expression of variation of temperature of fluid flowing at constant pressure.	2	2
8	Differentiate hydrodynamic& thermodynamic behavior fluids.	2	2
9	Sketch the concentration profile for component A in the flowing fluid over soluble flat wall.	3	2
10	Calculate the time smoothed concentration from the concentration reading 8,13,12,20,19,17 g/ml measured at a same location for the fluid flow through circular pipe.	3	3
11	Correlate the relation of mass diffusivity with momentum and thermal diffusivity.	3	2
12	List the dimensionless number used to represent the enhancement of mass transfer in reacting systems.	3	2
13	Compare macroscopic model and microscopic model on transport problems.	4	2

14	Analyze the Maxwellian (equilibrium) distribution in theory of diffusion in colloidal suspensions.	4	4
15	Relate Friction factor with Reynold's number,	4	2
16	Distinguish friction factor and friction loss factor for a viscous flow.	4	2
17	Write the significance of Hatta number.	5	2
18	Connect the following governing equation of motion to the relevant physics	5	2

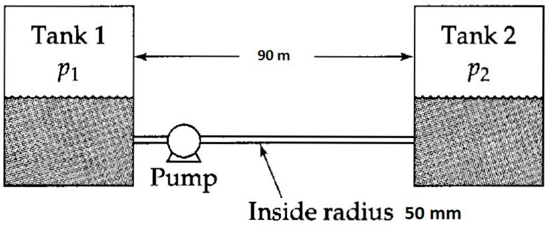
$$\rho\left(v_x\frac{\partial v_x}{\partial x}+v_y\frac{\partial v_x}{\partial y}\right)=\rho v_e\frac{dv_e}{dx}+\mu\frac{\partial^2 v_x}{\partial y^2}+\bar{\rho}g_x\bar{\beta}(T-T_\infty)+\bar{\rho}g_x\bar{\zeta}(\omega_A-\omega_{A\infty})$$

19	Interpret the significance of dimensionless number in Interphase transfer.	5	3
20	Analyze the macroscopic balance to solve steady state problems.	5	4

PART- B (5x 10=50Marks)

		Marks	CO	BL
21 (a)	Compile the techniques used for solving analytically the partial differential equations and explain any one technique with a case study.	**(10)**	**1**	**3**
	(OR)			
21 (b)	Describe the pressure distribution of a creeping flow of fluid on sphere.	**(10)**	**1**	**3**
22 (a)	Derive an temperature distribution expression for a viscous fluid on conduction.	**(10)**	**2**	**4**
	(OR)			
22 (b)	A solid material occupying the space from y = 0 to y = ∞ is initially at temperature T0. At time t = 0, the surface at y = 0 is suddenly raised to temperature T1 and maintained at that temperature for t > 0. Devise the time – dependent temperature profile T(y,t).	**(10)**	**2**	**4**
23 (a)	Devise the time smoothened equation of continuity of component A & explain the analogy used.	**(10)**	**3**	**1**
	(OR)			
23 (b)	Derive the continuity equation for multi component system in the form of mass fraction and molar fraction by obeying Fick's law of diffusion.	**(10)**	**3**	**1**
24 (a)	A dilute HCl solution of constant density 999 kg/m^3 and viscosity	**(10)**	**4**	**4**

0.001 kg/ms is to be pumped from tank 1 to tank 2 with no overall change in elevation. The pressure in the gas spaces of the two tanks are P1 = 1 atm & P2 = 4 atm. The pipe radius is 50 mm and the Reynolds number is 7.11 x 104. The average velocity in the pipe is to be 0.7 m/s and friction factor is 0.0049. Calculate the power must be delivered by the pump.



(OR)

		Marks	CO	BL
24 (b)	Derive a macroscopic mechanical energy balance for Non – Isothermal system and explain different situations for evaluating the integral $\int dp$ between P_1 & P_2	**(10)**	**4**	**4**
25 (a)	Gas A is absorbed by a stationery liquid solvent S, the solution has solute B. Species A reacts with B in an instantaneous irreversible rapid reaction according to the equation aA + bB => Products. Assume the Fick's second law adequately describes the diffusion processes, since A, B and the reaction products are present in solvent in low concentrations. Devise the model insensitive correlations for this system.	**(10)**	**5**	**3**
	(OR)			
25 (b)	Develop the transfer coefficient for single phase and analytical expression mass transfer coefficient with suitable example.	**(10)**	**5**	**3**

PART- C (1x 10=10Marks)

(Q.No.16 is compulsory)

		Marks	CO	BL
26.	Water and air are separated by a mild steel plane wall. It is proposed to increase the heat transfer rate between these fluid by adding straight square fins of 1.27mm thick and 2.5 cm length, 1.27cm apart. The air	**(10)**	**2**	**5**

side and water side heat transfer coefficients are 11.4 and 256 W/m^2. K. Evaluate and Analyze the percentage change in total heat transfer when the fins are placed on

1. Water side
2. Air side
3. Both sides