Seat No./Enrollment No.: _____

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 8 – EXAMINATION – SUMMER 2026

Subject Code: 2180507 **Date: 25/05/2026**

Subject Name: Transport Phenomena

Time: 10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1	**(a)**	Define Scalar, Vector and Tensor quantities used in transport phenomena with examples	**03**
	(b)	Discuss the application of transport phenomena in Chemical Engineering	**04**
	(c)	Derive the expression of velocity distribution and momentum flux for Couette Viscometer.	**07**
Q.2	**(a)**	Explain the concept of shell momentum balance in fluid flow. State the general boundary conditions used in solving momentum transport problems.	**03**
	(b)	Develop the steady state temperature profile for solid slab between two parallel plates with explanation of molecular heat transport.	**04**
	(c)	Water at $20^{\circ}C$ is flowing down a vertical wall with Re = 10. Calculate (a) the flow rate and (b) the film thickness in inches. given data: density= 998.2 kg/m^3, viscosity= $1.002*10^{-3}$ kg.m/s and kinematic viscosity =$1.0038*10^{-6}$ m^2/s.	**07**
		OR	
	(c)	A thermocouple in a cylindrical well inserted into a gas stream. Estimate the true temperature of gas stream if temperature indicated by thermocouple $T_1 = 500^{\circ}F$, wall temperature $T_W = 350^{\circ}F$. Given data: h= 120 btu / hr. Ft^2. F, k= 60 btu / hr. Ft^3. F , thickness of well wall B=0.08 in , length of well L= 0.2 ft.	**07**
Q.3	**(a)**	State and explain Fourier's Law of Heat Conduction with its mathematical expression.	**03**
	(b)	Discuss the dependence of thermal conductivity on temperature and pressure.	**04**
	(c)	Develop the temperature distribution equation for steady-state heat conduction in a plane wall with uniform chemical heat generation. State all assumptions clearly.	**07**
		OR	
Q.3	**(a)**	What is Thiele Modulus?	**03**
	(b)	Describe the velocity distribution and shear stress distribution in laminar flow through an annulus.	**04**
	(c)	Develop the temperature distribution equation for steady-state heat conduction in a plane wall with uniform electrical heat generation. State all assumptions clearly.	**07**
Q.4	**(a)**	Prove that $J_a + J_b = 0$	**03**
	(b)	Explain various experimental and theoretical methods used to determine critical diffusivity $(CD_{AA})_c$.	**04**
	(c)	Derive the expression for molar flux for equimolar counter diffusion of components A and BDerive the expression for molar flux for equimolar counter diffusion of components A and BDerive the expression for molar flux for equimolar counter diffusion of components A and BDerive the expression for molar flux for equimolar counter diffusion of components A and B.	**07**
		OR	
Q.4			

(a) Define combine molar and mass flux. **03**

(b) Estimate D_{AB} for the system CO-CO_2 at 296.1 K and 1 atm total pressure. **04**

Properties: a= $2.745*10^{-4}$, b= 1.823

Species	Tc (K)	Pc (atm)
CO	133	34.5
CO_2	304.2	72.9

(c) Discuss the diffusion of a gas through a stagnant gas film. Derive the governing equation for molar flux and state the assumptions involved. **07**

Q.5

(a) Define Prandtl number. Explain how its value varies for gases, liquids. **03**

(b) Why is diffusion in liquids slower than in gases? Explain in terms of molecular interactions. **04**

(c) Using conservation of mass, derive the general continuity equation in Cartesian coordinates and explain its physical significance. **07**

OR

Q.5

(a) Define Schmidt number. Explain how its value varies for gases, liquids, and polymer suspensions. **03**

(b) Why is heat conduction in metals higher than in non-metals? Explain based on molecular transport mechanism. **04**

(c) Derive the Navier-Stoke's equation in cylindrical coordinate. **07**

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