

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**BE - SEMESTER-VIII (NEW) EXAMINATION – WINTER 2023**

**Subject Code: 2180507****Date: 06-12-2023****Subject Name: Transport Phenomena****Time: 02:30 PM TO 05:00 PM****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

|            |                                                                                                                                                                                              | Marks     |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>Q.1</b> | <b>(a)</b> Differentiate between macroscopic and microscopic transport process.                                                                                                              | <b>03</b> |
|            | <b>(b)</b> Write the Maxwell expression for viscosity of gas at low density.<br>How do the viscosities of liquids and low-density gases depend on the temperature and pressure?              | <b>04</b> |
|            | <b>(c)</b> Develop an expression for Navier-Stokes Equation in Cylindrical Co-ordinate system.                                                                                               | <b>07</b> |
| <b>Q.2</b> | <b>(a)</b> Compare and contrast the procedures for solving laminar flow problems and turbulent flow problems.                                                                                | <b>03</b> |
|            | <b>(b)</b> Compare and contrast the molecular and convective mechanisms for momentum transport.                                                                                              | <b>04</b> |
|            | <b>(c)</b> Develop the shear stress and velocity distribution profile for the laminar flow in the narrow slit. State assumptions made while deriving these expressions.                      | <b>07</b> |
| <b>OR</b>  |                                                                                                                                                                                              |           |
|            | <b>(c)</b> Develop the shear stress and velocity distribution profile for the upward laminar flow through annulus. State assumptions made while deriving these expressions.                  | <b>07</b> |
| <b>Q.3</b> | <b>(a)</b> Define the following:<br>(1) Fourier's law of heat conduction.<br>(2) Isotropic and Anisotropic thermal conductivity.<br>(3) Steady state temperature profile                     | <b>03</b> |
|            | <b>(b)</b> Compare the temperature dependence of the thermal conductivities of gases, liquids, and solids.                                                                                   | <b>04</b> |
|            | <b>(c)</b> Develop the heat flux and temperature distribution profile for heat conduction in a wire involving electric heat source. State assumptions made while deriving these expressions. | <b>07</b> |
| <b>OR</b>  |                                                                                                                                                                                              |           |
| <b>Q.3</b> | <b>(a)</b> What is the significance of Prandtl no and Peclet no.                                                                                                                             | <b>03</b> |
|            | <b>(b)</b> How force convection and free convection differ from each other? Explain with suitable example.                                                                                   | <b>04</b> |
|            | <b>(c)</b> Develop the heat flux and temperature distribution profile for heat conduction involving chemical heat source. State assumptions made while deriving these expressions.           | <b>07</b> |
| <b>Q.4</b> | <b>(a)</b> Define the following:<br>(1) Mass average velocity (2) Molar average velocity.                                                                                                    | <b>03</b> |
|            | <b>(b)</b> To solve the heat equation for the temperature distribution in a medium, boundary conditions must be prescribed at the surfaces of the medium.                                    | <b>04</b> |

- What physical conditions are commonly used for this purpose?
- (c) Derive an expression for diffusion of liquid A evaporating in to non-diffusing gas B. **07**

**OR**

- Q.4** (a) Define the following: **03**  
 (1) Molecular mass flux (2) Molecular molar flux
- (b) What purpose is served by attaching fins to a surface? What is fin effectiveness? Under what conditions are fins most effective? **04**
- (c) Derive the expression for concentration profile of gas A involving diffusion of gas A into liquid B with a first order irreversible homogeneous chemical reaction  $A+B \rightarrow AB$ . **07**
- Q.5** (a) Discuss the term "diffusion-controlled reaction." **03**
- (b) Distinguish between homogeneous and heterogeneous reactions. Which ones are described by boundary conditions and which ones manifest themselves in the differential equations? **04**
- (c) Write in brief about equation of continuity for a multicomponent mixture. **07**

**OR**

- Q.5** (a) Define the following for porous catalytic surface: **03**  
 (1) Thiele modulus (2) effectiveness factor
- (b) Prove that for equimolar counter diffusion  $D_{AB} = D_{BA}$ . **04**
- (c) Derive the expression for concentration profile of gas A diffusing in the porous spherical solid catalyst and form product  $A \rightarrow B$ . **07**
- Where,  
 $R_A = -k''_1 a C_A$  where,  $a$  = available catalytic surface per unit volume  
 Boundary conditions:  $C_A = C_{AR}$ , at  $r = R$ ,  $C_A$  is finite at  $r = 0$ .

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