Enrolment No./Seat No_____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE- SEMESTER– VII EXAMINATION – SUMMER 2026**

**Subject Code:3170511 Date:08-06-2026**

**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.**
4. **Simple and non-programmable scientific calculators are allowed.**

**Q.1** **(a)** Compare momentum, heat and mass transport process **03**

**(b)** Apply shell momentum balance for steady flow, and write necessary boundary conditions used to solve the same. **04**

**(c)** Determine the mass flow rate expression for a flow through circular pipe. **07**

**Q.2** **(a)** Show that tensor $\boldsymbol{\tau}$ is antisymmetric, Where, $\boldsymbol{\tau} = -\boldsymbol{\delta}_1\boldsymbol{\delta}_2 + 3\boldsymbol{\delta}_1\boldsymbol{\delta}_3 + \boldsymbol{\delta}_2\boldsymbol{\delta}_1 + 5\boldsymbol{\delta}_2\boldsymbol{\delta}_3 - 3\boldsymbol{\delta}_3\boldsymbol{\delta}_1 - 5\boldsymbol{\delta}_3\boldsymbol{\delta}_2$. **03**

**(b)** Show that for tensor $\boldsymbol{\tau}$ and vector $\boldsymbol{v}$, $\boldsymbol{\tau} \times \boldsymbol{v} = \sum_i \sum_l \boldsymbol{\delta}_i\boldsymbol{\delta}_l \{\sum_j \sum_k \varepsilon_{jkl}\tau_{ij}\, v_k\}$ **04**

**(c)** Estimate the viscosity of the following gas mixture at 1 atm and 293K from the given data on the pure components at the same pressure and temperature **07**

| Species α | Mole fraction, $x_\alpha$ | Molecular Weight, $M_\alpha$ | Viscosity, $\mu_\alpha$ (g/cm·s) |
|---|---|---|---|
| 1.$CO_2$ | 0.133 | 44.01 | $1462\times10^{-7}$ |
| 2. $O_2$ | 0.039 | 32 | $2031\times10^{-7}$ |
| 3.$N_2$ | 0.828 | 28.02 | $1754\times10^{-7}$ |

**OR**

**(c)** Estimate the thermal conductivity of the following gas mixture at 1 atm and 293K from the given data on the pure components at the same pressure and temperature. **07**

| Species α | Mole fraction, $x_\alpha$ | Molecular Weight, $M_\alpha$ | Viscosity, $\mu_\alpha\times10^7$ (g/cm·s) | $k_\alpha\times10^7$ (cal/cm·s·K) |
|---|---|---|---|---|
| 1.$CO_2$ | 0.133 | 44.01 | 1462 | 383 |
| 2. $O_2$ | 0.039 | 32 | 2031 | 612 |
| 3.$N_2$ | 0.828 | 28.016 | 1754 | 627 |

**Q.3** **(a)** Explain law of conservation of mass for two colliding homo-nuclear diatomic molecules. **03**

**(b)** Compare free convection and forced convection heat transfer **04**

**(c)** Derive velocity profile and mass flow rate for flow of a falling film formed by a Newtonian, incompressible fluid. **07**

**OR**

| | | | |
|---|---|---|---|
| **Q.3** | **(a)** | Explain law of conservation of momentum for two colliding homo-nuclear diatomic molecules. | **03** |
| | **(b)** | Discuss different boundary conditions used for solving shell energy balance. | **04** |
| | **(c)** | Derive an expression for effectiveness of cooling fin of length L, Width W, and thickness 2B, where B<<W and B<<L. | **07** |
| **Q.4** | **(a)** | Explain the Newton's law of viscosity. | **03** |
| | **(b)** | Explain law of conservation of angular momentum for two colliding homo-nuclear diatomic molecules. | **04** |
| | **(c)** | Develop the equation of motion in Cartesian coordinates with neat diagram and necessary assumptions. | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.4** | **(a)** | Explain the Fourier's law of heat conduction. | **03** |
| | **(b)** | Explain law of conservation of energy for two colliding homo-nuclear diatomic molecules. | **04** |
| | **(c)** | Develop the Navier-Stoke's equation in Cartesian coordinate with neat diagram and necessary assumptions | **07** |
| **Q.5** | **(a)** | Explain the Fick's law of binary diffusion. | **03** |
| | **(b)** | Explain temperature and pressure dependency of diffusivity. | **04** |
| | **(c)** | Derive the relation of molar flux for diffusion Through a Stagnant Gas Film. | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.5** | **(a)** | Explain Mass and Molar Concentrations, Mass Average and Molar Average Velocities, Molecular Mass and Molar Fluxes. | **03** |
| | **(b)** | Write the general shell mass balance equation and necessary assumptions for solving the mass transport problems. | **04** |
| | **(c)** | With neat diagram derive an equation of molar flux for the diffusion with heterogeneous chemical reaction as  | **07** |

**********