Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**ME - SEMESTER–IV • EXAMINATION – SUMMER 2015**

**Subject Code: 741601 Date: 01/05/2015**

**Subject Name: Advanced Transport Phenomena**

**Time: 2:30 pm to 5:00 pm Total Marks: 70**

**Instructions:**

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

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|---|---|---|---|
| **Q.1** | **(a)** | Derive equation of continuity with usual notations. | **07** |
| | **(b)** | Discuss about friction factors for flow in tubes | **07** |
| **Q.2** | **(a)** | A spherical tank of radius R and its drainpipe of length L and diameter D are completely filled with heavy oil. At time t=0, the valve at the bottom of the drainpipe is opened. How long it will take to drain the tank. There is a air vent at the top of the spherical tank. Ignore the amount of oil that clings to the inner surface of the tank and assume that the flow is laminar. | **07** |
| | **(b)** | Calculate the pressure gradient required to flow a fluid in horizontal smooth circular tube of inside diameter 6 cm at a mass rate of 1200 g/s at 20$^{o}$C. At this temperature the density of the fluid is 0.9 g/cc and its viscosity is 1.9 cp. Assume suitable value of friction factor. | **07** |
| | | **OR** | |
| | **(b)** | For turbulent flow in ducts, discuss estimation of average velocity in a circular tube and application of Prandtlôs mixing length formula. | **07** |
| **Q.3** | **(a)** | Develop model for temperature profile for a steady state forced convection process in a cirular tube. | **07** |
| | **(b)** | Define turbulent Prantdl number and discuss time smoothed temperature profile near a wall. | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | Discuss estimation of heat transfer coefficient for forced convection around submerged objects. | **07** |
| | **(b)** | Air is flowing past a sphere having a diameter of 55 mm and an average surface temperature of 82.2$^{o}$C. The air is at 1 atm. absolute pressure and 15.6$^{o}$C with a velocity of 12 m/s. Estimate average heat transfer coefficient for air flowing past sphere having following data<br>k = 0.028 w/m. K Density= 1.1 kg/m$^3$<br>$\mu$ = 1.96 x 10$^{-5}$ Pa.s Npr = 0.74 | **07** |

**(P.T.O.)**

**Q.4** **(a)** For forced convection through tubes and slits, describe about calculation of heat transfer coefficient. **07**

**(b)** For a system of two concentric porous spherical shells, inner surface of outer shell is at temperature $T_1$ and the outer surface of inner shell is at lower temperature $T_k$. Dry air at $T_k$ is blown outward radially from inner shell into intravening space and then through outer shell. Develop an expression for required rate of heat removal from inner sphere as function of mass flow rate of flow of gas. **07**

**OR**

**Q.4** **(a)** Define Hatta number and discuss model insensitive correlation for absorption with rapid reaction in case of mass transfer and chemical reaction. **07**

**(b)** Discuss in detail about Computational fluid Dynamics. **07**

**Q.5** **(a)** Discuss in brief about mass transfer coefficient in falling film and plane surfaces. **07**

**(b)** Develop concentration profile equation for diffusion with homogeneous chemical reaction **07**

**OR**

**Q.5** **(a)** Discuss briefly about Marangoni effect related to effects of interfacial forces on Heat and mass transfer. **07**

**(b)** Calculate the value of the mass transfer coefficient for a sphere of naphthalene to air at $45^{o}$ C and 1 atm. abs flowing at a velocity of 0.36 m/s. The diameter of the sphere is 30 mm. The diffusivity of naphthalene in air at $45\ ^{o}$ C is $7.0 \times 10^{-6}$ $m^2$ /s and the vapor pressure of solid naphthalene is 0.58 mm Hg. The other relevant data of air is as follows. **07**

Density of air = 1.113 $kg/m^3$

Viscosity of air $\mu = 1.93 \times 10^{-5}$ Pa. s

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