Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

I SEMESTER M.TECH. (CHEMICAL ENGINEERING)

SEMESTER EXAMINATIONS, NOV- 2017

SUBJECT: ADVANCED TRANSPORT PHENOMENA[CHE 5102]

REVISED CREDIT SYSTEM
(18 /11/2017 FN)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer ALL questions.
- Missing data may be suitably assumed.
- Use of Transport Phenomena tables allowed.

1. A forced convection mass transfer in which the viscous flow and diffusion occurs under such conditions that the velocity fields can be virtually unaffected by diffusion. Also consider absorption of gas A by laminar flowing film of liquid B where the material A is slightly soluble in B so that viscosity of liquid is not changed appreciably. The diffusion takes place so slowly in the liquid film that the air will not penetrate very far into B so that the penetration distance is small in comparison with the film thickness. Derive the concentration profile for the above system. **10**

2. Consider two concentric spherical shell of radius kR and R. The inner surface of the outer sphere is at temperature T_1 and the outer surface of the inner sphere is at lower temperature T_k. By blowing air outwardly radial from the inner shell into the intervening space and out through the outer shell. Develop an expression for the(i)temperature profile (ii) rate of heat removal from the inner sphere as a function of mass rate of flow of gas. Assume steady state, laminar flow and low gas velocity. **10**

3. A fluid of constant density and viscosity is in a cylindrical container of radius R. The container is caused to rotate about its own axis at an angular velocity Ω. The cylindrical axis is vertical so that $g_r = g_{\theta=} 0$ and $g_z = -g$. Find the shape of the free surface when steady state is established. **10**

4. An incompressible fluid flow in the annular region between two co-axial cylinder of radius R and kR. Derive the velocity distribution and volumetric flow rate. **10**

5A. Compare Fick's law of diffusion with Newton's law of viscosity and Fourier's law of thermal conductivity. To what extent the expression are analogous **05**

5B. The door of the domestic refrigerator has an area of $0.7m^2$. It consists of a metal sheet of 3mm thick (K=40 W/m ^oC) with a 25mm thick layer of insulation (K=0.25 W/m^oC) on the inside with $h_i=h_o = 10$ W/m^2 ^oC. Determine the heat flow rate through the door and the temperature of the surface of the metal sheet if the refrigerator and room temperature are 0^oC and 20^oC respectively. **05**

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