Paper Code: ECH-801 **Roll No.** | | | | | | | | | | |

B.Tech.
(SEM VIII) EVEN SEMESTER EXAMINATION, 2015-2016
TRANSPORT PHENOMENA

[Time: 3 Hours] **[Total Marks: 100]**

Note:- Attempt all questions. All questions carry equal marks. Assume suitable data (if missing)

1. Attempt any four parts of the followings:- **[5x4=20]**

(a) What is continuum hypothesis in fluid mechanics?
(b) Discuss the similarity between momentum, heat and mass transfer.
(c) State Newton's law of viscosity? Explain each term clearly.
(d) What is meant by the term "non-Newtonian"? What types of substances exhibit this behaviour?
(e) Write the shell momentum balance equation for steady state and describe how momentum is being transferred?
(f) What are the assumptions that are applied in the development of Hagen-Poiseulle law?

2. Attempt any two parts of the followings:- **[10x2=20]**

(a) Derive an expression for the shear stress and velocity distribution for a flow of a falling film. Also find the maximum and average velocity.

(b) One method of determining the radius of a capillary tube is to measure the rate of flow of viscous fluids through the tube. Find the radius of a capillary from the flowing data:

Length of capillary	= 50.02 cm.
Kinematic viscosity of the fluid	= 4.03 x 10^{-5} $m^2 sec^{-1}$
Density of fluid	= 0.9552 x 103 kg m^{-3}
Pressure drop across (horizontal) capillary tube	= 4.829 x 10^5 newton m^{-2} = 4.766 atm
Mass rate of flow through tube	= 2.997 x 10^{-3} kg sec^{-1}

(c) Derive equation of continuity in rectangular coordinates system by means of a mass balance over a stationary volume element $\Delta x\ \Delta y \Delta z$.

3. Attempt any two parts of the followings:- **[10x2=20]**

(a) A horizontal annulus is 27 ft long. The outside radius of the inner cylinder is 0.495 in.; the inside radius of the outer cylinder is 1.1 in. A 60 percent aqueous solution of sucrose ($C_{12}H_{22}O_{11}$) is to be pumped through the annulus at 20^0C. At this temperature, the fluid density is 80.3 lb ft^{-3} and the viscosity is 136.8 $lb_m ft^{-1} hr^{-1}$. What is the volume rate of flow when the impressed pressure drop is 5.39 psi?

(b) A hollow steel sphere, 5.00 mm in diameter, with a mass of 0.0500 g, is released in a column of liquid to attain a terminal velocity of 0.500 cm sec-1. The liquid density is 0.900 gm cm-3. The local acceleration of gravity is 980.7 cm sec-2. The sphere is far enough from the containing walls so that their effect may be neglected.
(i) Compute the drag force in dynes.
(ii) Compute the drag coefficients (friction factor)
(iii) Determine the viscosity of the liquid in centipoises

(c) Derive the equation giving the velocity distribution at steady state for laminar flow of a constant density fluid with constant viscosity which is flowing between two flat and parallel plates at a distance $2y_o$ apart. The velocity profile desired is at a point far from the inlet or outlet of the channel. The two plates will be considered to be fixed and of infinite width, with the flow driven by the pressure gradient in the x-direction.

Following equation may be of use.

$$\rho\left(\frac{\partial u_x}{\partial t}+u_x\frac{\partial u_x}{\partial x}+u_y\frac{\partial u_x}{\partial y}+u_z\frac{\partial u_x}{\partial z}\right)=-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 u_x}{\partial x^2}+\frac{\partial^2 u_x}{\partial y^2}+\frac{\partial^2 u_x}{\partial z^2}\right)+\rho g_x$$

4. Attempt any two parts of the followings:- **[10x2=20]**

(a) Derive an expression of temperature distribution for a heat conduction with a viscous heat source. Also write the importance of Brinkman number appeared in such a development.

(b) A copper wire has a radius of 2mm and a length of 5m. For what voltage drop would the temporise rise at the wire axis be 10˚C, if the surface temperature of the wire is 20˚C?

(For copper, Lorene number=$\left(\frac{K}{Ke\,T0}\right)$=2.23 X 10^{-8} volt² ˚K^{-2})

(c) Differentiate between free convection and forced convection. Also write the physical significance of dimensionless numbers which appears in these convection processes.

5. Attempt any two parts of the followings:- **[10x2=20]**

(a) A mixture of He and N_2 gas is contained in a pipe at 298 K and 1 atm total pressure which is constant throughout. At one end of the pipe at point 1, the partial pressure p_{A1} of He is 0.60 atm and at the other end 0.2 m (20 cm), p_{A2} = 0.20 atm. Calculate the flux of the He at steady state, if D_{AB} of the He-N_2 mixture is 0.687 x 10^{-04} m^2/s (0.687 cm2/s)

(b) Derive an expression to concentration profile for diffusion through a stagnant gas film.

(c) (i) Define the term ‘effectiveness factor’ for the diffusion and chemical reaction inside a porous catalyst.

(ii) Describe the shell mass balance approach and the possible boundary conditions used.