**SF-374**

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# B.E. (Chemical Engineering) (Semester - VIII) (New) (Revised) Examination, November - 2017

## TRANSPORT PHENOMENA

## Sub. Code : 68536

**Day and Date : Thursday, 02 - 11 - 2017** **Total Marks : 100**

**Time : 10.00 a.m. to 1.00 p.m.**

**Instructions :** 1) **Answer any three questions from each section.**
2) **Assume suitable data if required.**
3) **Draw neat diagrams wherever necessary.**

## SECTION - I

**Q1)** a) State and explain Newton's law and explain temperature dependence of viscosity. How viscosity can be evaluated at required temperature. **[6]**

b) Glycerine is flowing through a horizontal tube 1 ft long and with 0.1 in I D. For the pressure drop of 276 kpa, the volume rate of flow is $1.88 \times 10^{-6}$ $m^3$/sec. The density of glycerine is 1.261 gm/cc. From flow data calculate viscosity. **[6]**

c) Discuss partial, total and substantial time derivative. **[5]**

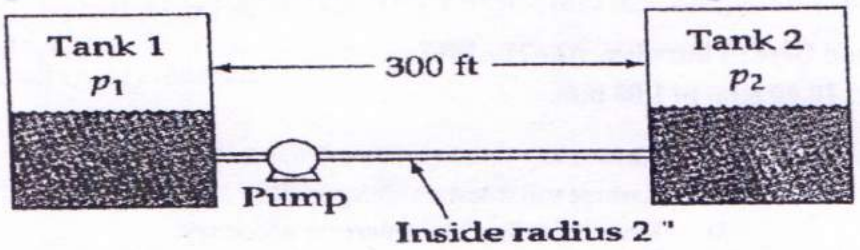
**Q2)** Develop an equation for film thickness δ for flow of viscous isothermal fluid film under influence of gravity with no rippling over an inclined flat plate and show that,

$$\delta = \sqrt{\frac{3\mu < V_z >}{\rho.g.\cos\beta}}$$

What is the ratio of the average velocity to the maximum velocity for this flow? **[16]**

***P.T.O.***

**Q3)** a) A dilute HCl solution of constant density and viscosity ($p = 990kg,/m^3$, $p = 1$ cp) is to be pumped from tank 1 to tank 2 with no overall change in elevation. The pressures in the gas spaces of the two tanks are $p_1 = 1atm$ and $p_2 = 4atm$. The pipe radius is 2 in. and the Reynolds number is $7.11 \times 10^4$. The average velocity in the pipe is to be 2.30 ft/s. What power must be delivered by the pump? **[8]**

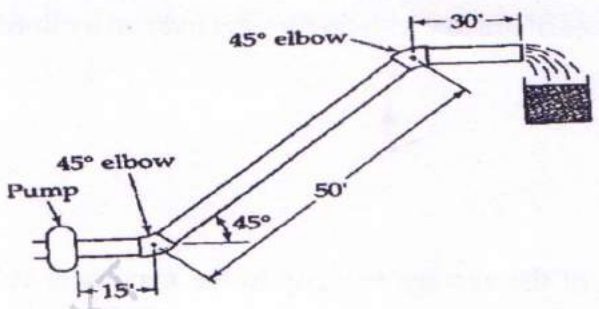



b) For flow around the spherical object derive equation for friction factor for Stokes law, Newtons law and intermediate region. **[8]**

**Q4)** a) For flow of an incompressible fluid through the tube, discuss estimation of viscous losses for straight tube and different fittings. **[9]**

b) Water at 25°C is to be pumped through 95 ft standard 3-in. pipe (internal diameter 3.068 in.) into an overhead reservoir.

What pressure is required at the outlet of the pump to supply water to the overhead reservoir at a rate of 18 gal/min? At 25°C the viscosity of water is 1.002 cp and the density is 0.9982 g/ml. Calculate friction factor using Blasius formula. The resistance of a 45" elbow, roughly equivalent to 15 diameters. (1 gal is 3.785 liters.) **[8]**



## SECTION - II

**Q5)** a) A copper wire of 1.016mm dia is insulated uniformly with plastic to an O.D. 3.048mm and is exposed to surrounding at 37.8°C. The heat transfer coefficient from outer surface of plastic to the surroundings is 8.52 w/ $m^2K$. What is the maximum steady current in amperes that this wire can carry without heating any part of the plastic above its operating limit of 93.3°C. **[8]**

| Data: | K [w/mK] | Ke [$ohm^{-1}\ cm^{-1}$] |
|---|---|---|
| Copper → | 380 | $5.1 \times 10^5$ |
| Plastic → | 0.346 | 0.0 |

b) Discuss unsteady state heat conduction equation for a solid cube. **[8]**

**Q6)** a) Water is flowing through a 0.0508m i.d. pipe at a rate of 2kg/sec. The inner wall temperature at some point along the tube is 70°C and the bulk fluid temperature at that point is 15°C. What is the local value of local heat flux at the wall surface? Assume that $h_{loc}$ is constant.

Data: properties of water at 42.5°C are

$= 0.620g \times 10^{-3}$ kg/m.sec, Cp = $3.768 \times 10^3$ J/kg C, K = 0.6291 watts/ mK

$$\frac{h_{loc} D}{K} = 5 + 0.025(Pr\,Re)^{0.8}$$ **[8]**

b) Explain the temperature and pressure dependence of mass diffusivity. **[8]**

**Q7)** a) Estimate diffusivity DAB for a dilute solution of Tri-nitrotolune [TNT] in benzene at 15°C.

Data: For Benzene

association parameter $\psi_B = 1.0$ $M_B = 78.11$

$\mu = 0.705Cp$ molar volume = $\bar{V}_B = 140\ cm^3/gm.mole$ **[8]**

b) Discuss the mechanism of diffusion through a stagnant gas film. **[8]**

**Q8)** Answer any Three. **[3 × 6 = 18]**

a) Explain Grid formation for computational fluid dynamics.

b) Macroscopic energy balance and energy balance for nonisothermal system.

c) Heat transfer coefficient for forced convection through packed bed.

d) Shell energy balance.

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