College of Engineering & Technology

Department: Mechanical Engineering
Lecturer: Dr. Rola Afify
Course Code: ME361

Marks: 20
Time: 12:30 – 2:00
Date: 27/7/2013

Name: **Model answer**

Answer the following questions:
Question One (9 marks)

A) Differentiate between:

1. Steady and unsteady flow.

② steady and unsteady flow (with respect to time) [from time to time)

$\frac{\partial}{\partial t} = 0$ — steady flow

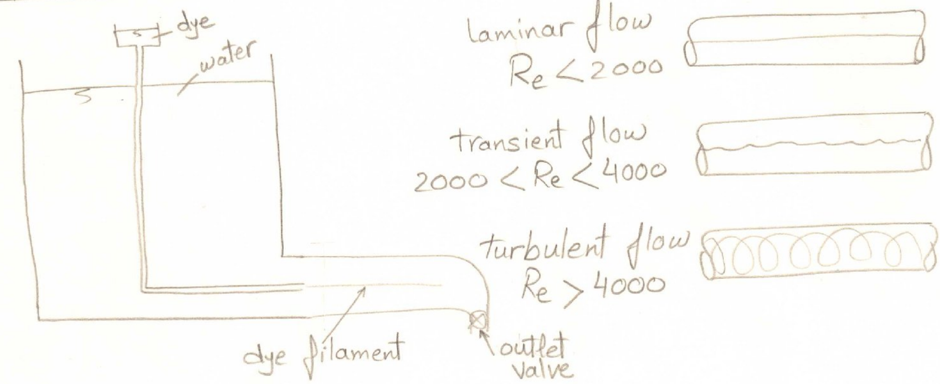
$\frac{\partial}{\partial t} \neq 0$ — unsteady flow

* steady flow: pressure, velocity, flow rate (flow parameters) are constant with respect to time.

* unsteady flow: any of the flow parameters change with time.

2. Laminar, transient and turbulent flow.

(4) Laminar, transient and turbulent flow



* laminar flow: (viscous flow, streamline flow)
The particles move in parallel lines (layers).

* Transient flow at which the dye filament begin to oscillate.

* Turbulent flow the dye color is diffused over the whole cross-section.

$$R_e = \frac{\rho V d}{\mu} \qquad \text{Reynolds number}$$

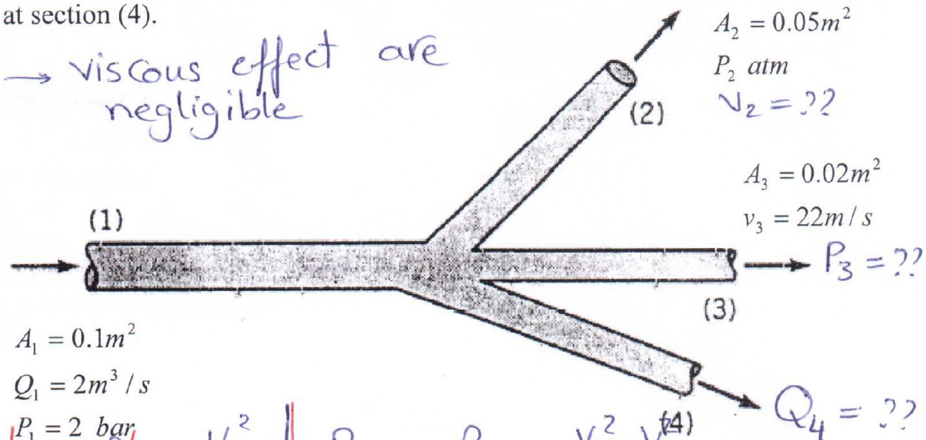
3. Friction and Eddy losses.

(1) Friction losses: This type of losses exists for any flow as a result of fluid viscosity and velocity difference between fluid layers. As a result of friction, part of the fluid's mechanical energy is converted into heat energy (decipated into atmosphere) and is considered as an energy loss.

(2) Eddy losses: occurs due to any change in the velocity vector (magnitude or direction). This change causes some of energy to be transfered from main flow to the eddies formed at corners. This part of energy is considered as energy losses.

Question Two (4 marks)

Water flows through the horizontal branching pipe, shown in figure, at a rate of $2\,m^3/s$. If the viscous effects are negligible, determine the water speed at section (2), the pressure at section (3) and the flowrate at section (4).



$h_{loss} = 0 \rightarrow$ viscous effect are negligible

$Q_1 = A_1 V_1$

$2 = 0.1\, V_1$

$\therefore V_1 = 20\, m/s$

B.E. 1 → 2

$$z_1 + \frac{P_1}{w} + \frac{V_1^2}{2g} = z_2 + \frac{P_2}{w} + \frac{V_2^2}{2g}$$

same horizontal plane; $P_2 = 0$ atm

$$\frac{V_2^2}{2g} = \frac{P_1}{w} + \frac{V_1^2}{2g}$$

$$V_2 = \sqrt{2g\left[\frac{P_1}{w} + \frac{V_1^2}{2g}\right]}$$

$$= \sqrt{2*9.8*\left[\frac{2*10^5}{9800} + \frac{(20)^2}{2*9.8}\right]}$$

$$= 20\sqrt{2}\ m/sec = 28.28\, m/s$$

B.E. 1 → 3

$$z_1 + \frac{P_1}{w} + \frac{V_1^2}{2g} = z_3 + \frac{P_3}{w} + \frac{V_3^2}{2g}$$

$$\frac{P_3}{w} = \frac{P_1}{w} + \frac{V_1^2 - V_3^2}{2g}$$

$$P_3 = P_1 + (V_1^2 - V_3^2) * 0.5\, \rho_w$$

$$= 2*10^5 + (20^2 - 22^2) * 0.5 * 1000$$

$$= 158000\ Pa = 1.58\ bar$$

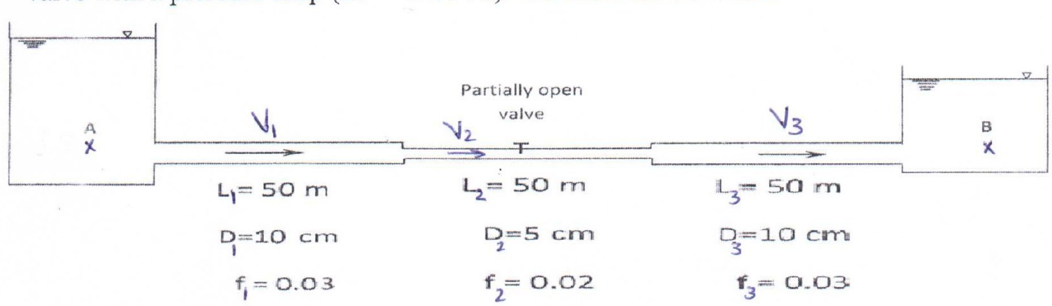
$$Q_1 = Q_2 + Q_3 + Q_4$$

$$2 = 28.28 * 0.05 + 22 * 0.02 + Q_4$$

$$Q_4 = 0.146\ m^3/sec$$

Question Three (7 marks)

Water flows from tank A to tank B due to level difference 6m. The line has a partially open valve with a pressure drop ($\Delta P = 1960$ Pa). Calculate the flow rate.



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$$E_A - E_B = h_{loss\,A \to B}$$

$$6 = K_{max\,cont.} \frac{V_1^2}{2g} + f_1 \frac{l_1}{d_1} \frac{V_1^2}{2g} + K_{max\,cont.} \frac{V_2^2}{2g} + f_2 \frac{l_2}{d_2} \frac{V_2^2}{2g} +$$

$$K_{max\,enl.} \frac{(V_2 - V_3)^2}{2g} + f_3 \frac{l_3}{d_3} \frac{V_3^2}{2g} + K_{max\,enl.} \frac{(V_3 - V_B)^2}{2g} + h_{loss\,Valve}$$

Vel. in tank = 0

$$6 = \frac{V_1^2}{2g} \left[0.5 + 0.03 * \frac{50}{0.1} + 0.5 * 4^2 + 0.02 * \frac{50}{0.05} + 1 (4-1)^2 + 0.03 * \frac{50}{0.1} + 1 \right] + \frac{1960}{9800}$$

$$V_1^2 = \frac{113.68}{[98.5]} = 1.154$$

$$V_1 = 1.074 \text{ m/sec}$$

$$Q = A_1 V_1$$

$$= \frac{\pi}{4} (0.1)^2 * 1.074$$

$$= 8.4 * 10^{-3} \text{ m}^3/\text{sec}$$

$$= 8.4 \text{ lit/sec}$$

$$Q = A_1 V_1 = A_2 V_2$$

$$\therefore V_2 = \frac{A_1 V_1}{A_2} = \left(\frac{D_1}{D_2}\right)^2 V_1 = \left(\frac{10}{5}\right)^2 V_1$$

$$\boxed{V_2 = 4 V_1}$$

$$Q = A_1 V_1 = A_3 V_3$$

$$\because D_1 = D_3$$

$$A_1 = A_3$$

$$\therefore \boxed{V_1 = V_3}$$