Alexandria Higher Institute of Engineering & Technology (AIET)		
Mechatronic Department		Third Year
EME312	Fluid Mechanics	Midterm, May, 5, 2011
Examiners:	Dr. Rola Afify and Committee	Time: 1.5 hours

Answer the following questions:

Question one (7 marks)

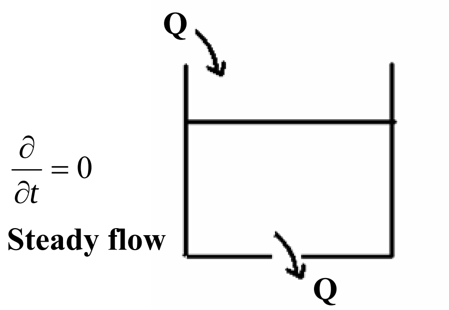
A) Define: Density, Streamline and Steady flow **(two degrees)**.

Solution

Density: mass per unit volume ($\rho = \frac{m}{V}$).

Streamline: a smooth imaginary curve represents one particle in the flow. The tangent of this line gives the direction of velocity at any point.

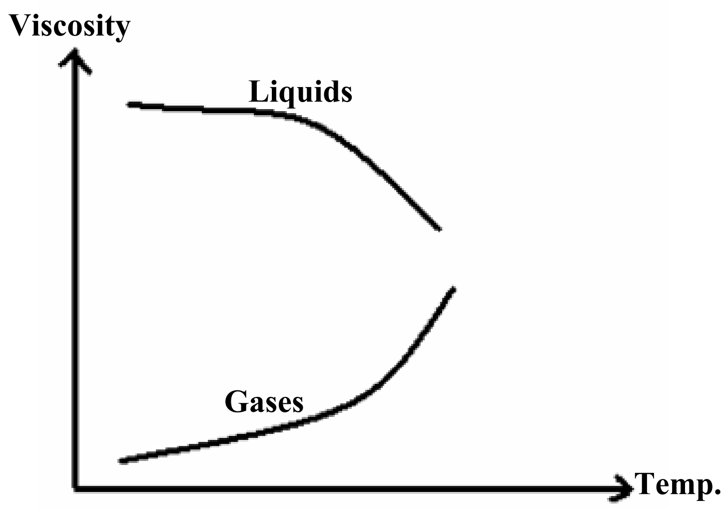
Steady flow: Flow parameters (pressure, velocity and volume flow rate) are constant with respect to time.



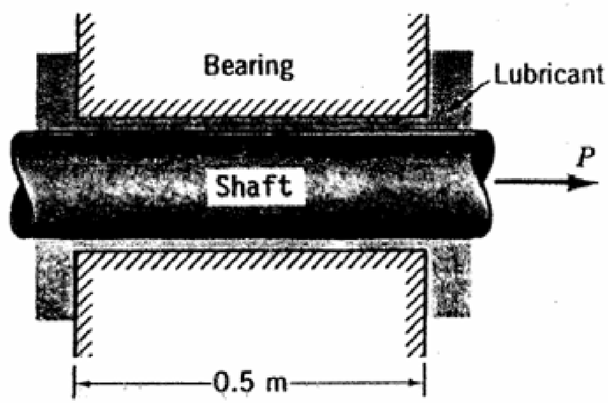
B) Sketch the relation between viscosity and temperature for a certain fluid **(two degrees)**.

Solution

The relation between viscosity and temperature for a certain fluid



C) A 25 mm diameter shaft is pulled through a cylindrical bearing as shown in Figure. The lubricant that fills the 0.3 mm gap between the shaft and bearing is oil having a kinematic viscosity of 8 x 10^{-4} m^2/s and a specific gravity of 0.91. Determine the force P required to pull the shaft at a velocity of 3 m/s. Assume the velocity distribution in the gap is linear. **(three degrees)**



Solution

d = 25mm, y = 0.3 mm, $\upsilon = 8x10^{-4} m^2/s$, sp.gr. = 0.91

P = ?? , u = 3 m/s, linear velocity distribution.

$$\upsilon = 8x10^{-4} = \frac{\mu}{\rho}$$

$$\rho = sp.gr.x\rho_{water} = 0.91x1000 = 910kg/m^3$$

$$\mu = \upsilon x\rho = 8x10^{-4}x910 = 0.728Pa.s$$

$$F_{visc} = \mu \ A \ \frac{du}{dy}$$

$$P = 0.728x(\pi dl)x\frac{3}{0.3x10^{-3}} = 0.728x(\pi \ x25x10^{-3}x0.5)x\frac{3}{0.3x10^{-3}} = 286N$$

Question two (7 marks)

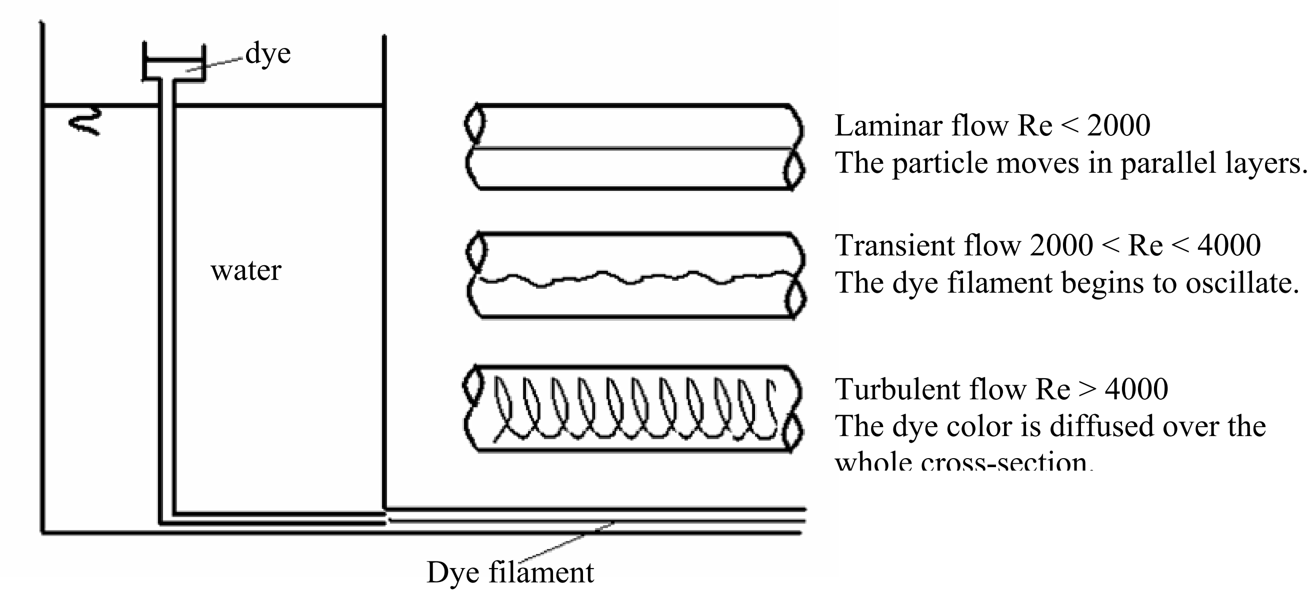
A) State the relation between absolute, atmospheric and gage pressure **(one degree)**.

Solution

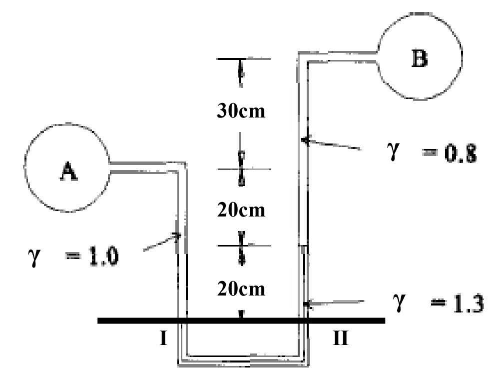
$$P_{abs} = P_{gage} + P_{atm}$$

B) Differentiate between Laminar, Transient and Turbulent flow **(three degrees)**.

Solution



C) A manometer is connected between two pipelines, A and B shown in figure. What is the pressure difference between A and B expressed as meters of water? **(three degrees)**



Solution

$$P_I = P_{II}$$

$$P_A + w_A h_1 = P_B + w_{man} h_2 + w_B h_3$$

$$h_1 = 40cm, \ h_2 = 20cm, \ h_3 = 50cm$$

$$P_A - P_B = w_{man} h_2 + w_B h_3 - w_A h_1$$

$$P_A - P_B = (1.3x9800)x(20x10^{-2}) + (0.8x9800)x(50x10^{-2}) - (1x9800)x(40x10^{-2})$$
$$\Delta P = P_A - P_B = 2{,}548 Pa.s$$
$$\Delta P = w_{water} h$$
$$h = \frac{\Delta P}{w_{water}} = \frac{2{,}548}{9800} = 0.26 \ m \ of \ water$$
$$= 26 \ cm \ of \ water$$

Question three (6 marks)

Water is flowing in the conduit shown in figure. If the flow rate Q is 8 lit/s and the diameters d_1, d_2 and d_3 at sections 1, 2 and 3 are 50, 60 and 100 mm respectively, find the flow velocities v_1, v_2 and v_3 **(two degrees)**. If the pressure P_1 at section 1 is 24.5 kPa, what are the pressures P_3 at sections 3 **(two degrees)**? Also, draw T.E.L. and H.G. for the conduit at the three sections (neglect losses) **(two degrees)**.

Solution

To get flow velocities v_1, v_2 and v_3

$$Q = A_1 v_1 = A_2 v_2 = A_3 v_3$$
$$8x10^{-3} = (\frac{\pi}{4} d_1^2) v_1 = (\frac{\pi}{4} d_2^2) v_2 = (\frac{\pi}{4} d_3^2) v_3$$
$$8x10^{-3} = (\frac{\pi}{4}(50x10^{-3})^2) v_1 = (\frac{\pi}{4}(60x10^{-3})^2) v_2 = (\frac{\pi}{4}(100x10^{-3})^2) v_3$$
$$v_1 = \frac{8x10^{-3}}{\frac{\pi}{4}(50x10^{-3})^2} = 4.07 \ m/s,$$
$$v_2 = \frac{8x10^{-3}}{\frac{\pi}{4}(60x10^{-3})^2} = 2.83 \ m/s,$$
$$v_3 = \frac{8x10^{-3}}{\frac{\pi}{4}(100x10^{-3})^2} = 1.02 \ m/s$$

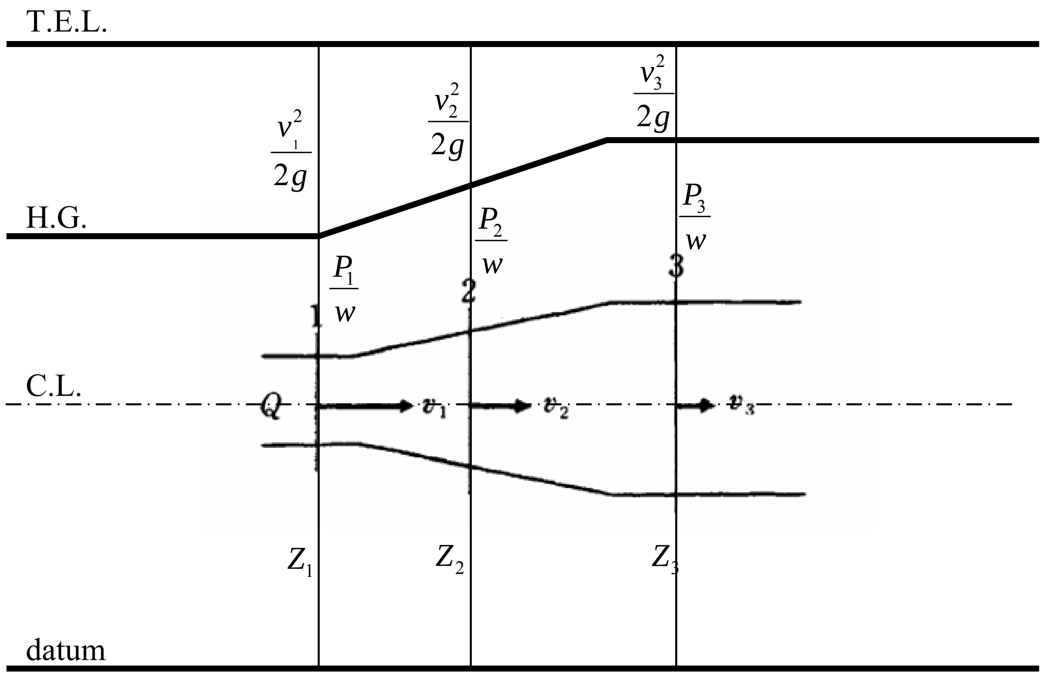
To get the pressures P_3 at sections 3

$$\frac{P_1}{w} + Z_1 + \frac{v_1^2}{2g} = \frac{P_3}{w} + Z_3 + \frac{v_3^2}{2g}$$

$Z_1 = Z_3$ at the same horizontal level

$$\frac{P_1}{w} + \frac{v_1^2}{2g} = \frac{P_3}{w} + \frac{v_3^2}{2g}$$
$$\frac{P_3}{w} = \frac{P_1}{w} + \frac{v_1^2}{2g} - \frac{v_3^2}{2g}$$
$$\frac{P_3}{9800} = \frac{24.5x10^3}{9800} + \frac{(4.07)^2}{2x9.8} - \frac{(1.02)^2}{2x9.8}$$

$$P_3 = 32{,}262.25\ Pa$$
$$= 32.3\ kPa$$



Good Luck