Fayoum University		2nd Year Electrical Engineering
Faculty of Engineering		Final Exam – Jan., 2015
Inustrial Engineering Dept.	Mechanical Engineering (2)	Time:3 Hours

- *If you make any assumption to reach a solution state it clearly.*

Answer all the following questions:

Question (1)

(1) The velocity profile is a laminar flow through a round pipe is expressed as, $u = 2U\left[1-\left(r^2/r_0^2\right)\right]$ where U = average velocity, r_0 = radius of pipe. Draw dimensionless shear stress profile $\left(\tau/\tau_0\right)$ against $\left(r/r_0\right)$ where τ_0 is wall shear stress. Find τ_0, when oil flows with absolute viscosity 4×10^{-2} N.s/m^2 and velocity of 4 m/s in a pipe of diameter 150 mm.

(2) Water flows steadily through the large tanks shown in **Figure (1)**. Determine the water depth, h_A.

Question (2)

(1) Water is being pumped from a low reservoir to a high reservoir, as shown in **Figure (2),** at a rate of 0.1 m^3/s. The loss of available energy for the pump/pipe combination is given by loss $= 3V^2/g$ (units of m) where V is flow velocity.

a) What is the shaft power, W (in watts), needed to keep the water flowing at the designated rate?

b) In terms of pressure heads, what is the shaft-head supplied by the pump and what is the head-loss?

(2) A cylindrical tank of diameter 3d contains water in which a solid circular cylinder of length l and diameter d floats with its axis vertical. Oil is poured into the tank so that the length of the float finally protruding above the oil surface is l/20. What vertical movement of the float has taken place? (Relative density of oil 0.8, of cylinder 0.9.).

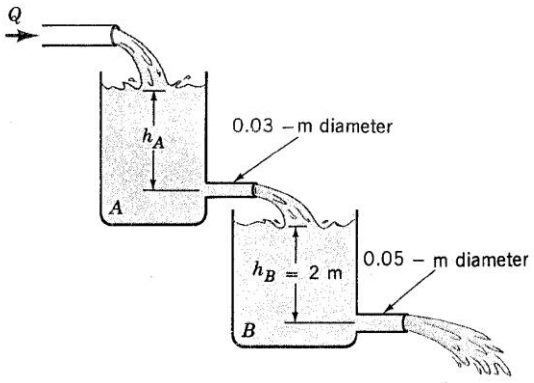

Fig. (1)

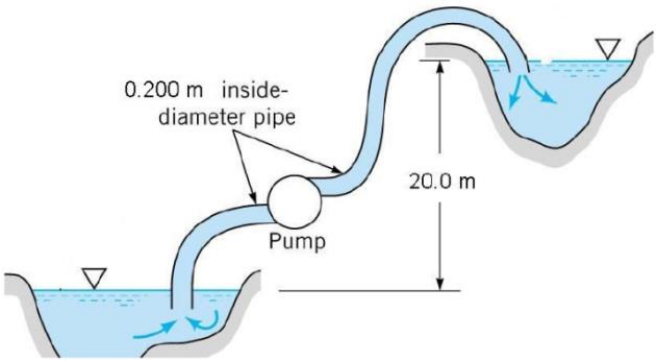

Fig. (2)

Please Turn Over

Question (3)

(1) The diameter of a pipe-bend is 300 mm at inlet and 150 mm at outlet and the flow is turned through 120◦ in a vertical plane. The axis at inlet is horizontal and the centre of the outlet section is 1.4 m below the centre of the inlet section. The total volume of fluid contained in the bend is 0.085 m^3. Neglecting friction, calculate the magnitude and direction of the net force exerted on the bend by water flowing through it at 0.23 m^3/s when the inlet gauge pressure is 140 kPa. **(see Figure (3))**

(2) A liquid of relative density 1.2 flows from a 50 mm diameter pipe A into a 100 mm diameter pipe B, the enlargement from A to B being abrupt. Some distance downstream of the junction is a total-head tube facing the oncoming flow; this is connected to one limb of a U-tube manometer containing mercury (relative density 13.6). The other limb of the manometer is connected to a tapping in the side of pipe A. Calculate the mass flow rate of the liquid when the difference of mercury levels is 50 mm. **(see Figure (4))**

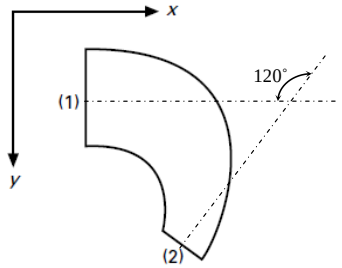

Fig. (3)

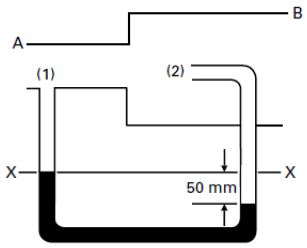

Fig. (4)

Question (4)

(1) What are the main components of basic hydraulic system?

(2) List major differences between nonpositive displacement and positive displacement pumps.

(3) Define cavitation and what is the effect of cavitation on pumps.

(4) Estimate the dimensions of the rotors of a gear wheel pump for the following duty: liquid oil of viscosity 4×10^{-4} m^2/s, overall efficiency = 0.6, volumetric efficiency = 0.9, number of teeth per rotor = 12, ratio of l/D = length/diameter = 1.5, ratio of D/C (where C is the distance between axes) = 1.18, discharge 350 lit/min, speed 750 rpm, pressure generated 10.5 kg/cm^2, what power input would be required?

Question (5)

(1) Define conduction, convection, radiation, evaporation and condensation, and explain how energy transfer takes place by both of them?

(2) Calculate the critical radius of asbestos insulation [k=0.172 w/mK] surrounding a pipe and exposed to room air at 300K with heat transfer coefficient h =2.8 Wm/K. Calculate the heat loss from a 475K, 60mm diameter pipe When covered with the critical radius of insulation and without insulation.

Best wishes

Dr. Emad M. Saad