Fayoum University		2nd Year Electrical Engineering
Faculty of Engineering		Final Exam – Jan., 2016
Mechanical Engineering Dept.	Mechanical Engineering (2)	Time:3 Hours

Answer all the following questions

Question (1)

a. A capillary rise experiment is proposed for a high school physics class. The students are told that for water at 20°C in clean glass tubes, the contact angle between liquid and glass θ is 90°. The students are asked to measure capillary rise in a series of tube diameters (D = 0.05 cm, 0.10 cm, 0. 15 cm, 0.20 cm). Graph the results and determine the approximate tube diameters that would produce capillary rises of 3 cm, 2 cm, and 1 cm. Predict the results if the water used in the experiment is 50°C. (σ = 0.073 N/m at 20°C)

b. A cylinder of diameter 122 mm and length 200 mm is placed inside a concentric long pipe of diameter 125 mm. An oil film is introduced in the gap between the pipe and the cylinder. What force is necessary to move the cylinder at a velocity of 1 m/s? Assume that the kinematic viscosity of oil is 30×10^{-6} m^2/s and the specific gravity is 0.9.

Question (2)

a. Explain the working principle of elastic-type mechanical pressure gauge with a neat sketch.

b. In ***Figure*** ***(Q2.b)***, atmospheric pressure is 100.663 Pa, the gage reading at **A** is 42058 Pa, and the vapor pressure of the alcohol is 11721 Pa. Compute x and y.

c. A liquid, specific gravity is 1.2, is rotated at 200 rpm about a vertical axis. At one point, **A**, in the fluid 2 ft from the axis, the pressure is 10 psi. What is the pressure at a point **B**, 4 ft higher than **A** and 3 ft from the axis?

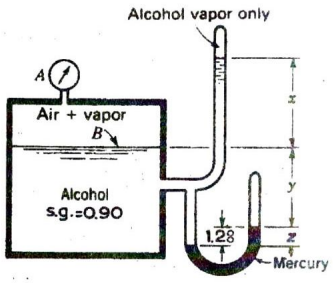

Fig. ***(Q2.b)***

Question (3)

a. For the water shooting out of the pipe and nozzle under the conditions shown in ***Figure*** ***(Q3.a)***, find the height above the nozzle to which the water jet will "shoot" (i.e., distance h in ***Figure*** ***(Q3.a)***). Assume negligible head loss.

b. ***Figure*** ***(Q3.b)*** shows a garden sprinkler. If the sprinkler nozzle diameter is 5 mm and the sprinkler velocity is 5m/s, what is the rate of rotation? What torque is required to hold the sprinkler stationary? Assume there is no friction.

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c. A flow nozzle is a device inserted into a pipe as shown in ***Figure (Q3.c)***. if A_2 is the exit area of the flow nozzle, show that for incompressible flow we get for Q,

$$Q = C_d\left[\frac{A_2}{\sqrt{1-(A_2/A_1)^2}}\sqrt{2g\left(\frac{p_1-p_2}{\gamma}\right)}\right]$$

Where C_d is the coefficient of discharge, which takes into account frictional effects and is determined experimentally

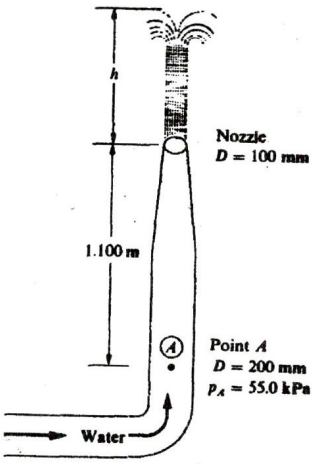

Fig. (Q3.a)

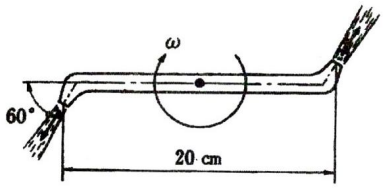

Fig. (Q3.b)

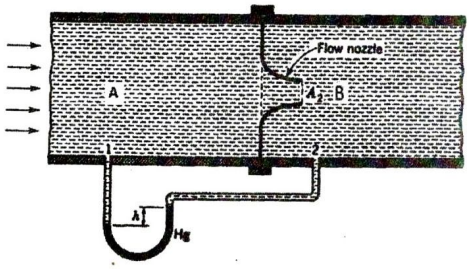

Fig. (Q3.c)

Question (4)

a. Compare among of electrical, hydraulic and pneumatic systems and explain the main components of hydraulic systems.

b. Explain graphically, why the actual brake horse power of the centrifugal pumps at zero discharge is more than in ideal case?

c. The 40 m long and 102 mm diameter commercial steel pipe connects reservoirs **A** and **B** as shown in ***Figure (Q2.a)***. The water flows from reservoir **A** to reservoir **B** with 10.1 liters/sec. *Reservoir A is subjected to atmospheric pressure*, all valves are fully open, and bend losses are negligible. (Loss coefficients of life-type check valve and globe valve are 12 and 5 respectively, and tube wall roughness height is 0.045 mm).

(i) Determine the pressure at each point designated in the figure.

(ii) Is the flow reaches into the reservoir **B?** If not, find the pumping station brake horse power required to solve this problem if pump with efficiency 80% is used.

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