ASSIGNMENT #1 FOR SEMM2313.

Question 1

Refer to Figure Q1 which is a pressurized benzene tank.

a) State one factor that affects the magnitude of the hydrostatic force acting on a submerged surface.

b) Determine the equivalent of benzene height for the air pressure.
[17.99 m]

c) Determine the horizontal and vertical forces experienced by the curved gate quarter cylinder AB. The width of the tank is 2 m and S.G for benzene is 0.85.
[FH=183.01 kN, FV=184.73 kN]

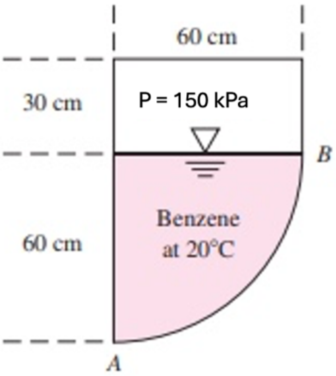

Figure Q1

Question 2

a) State one factor that affects the buoyancy force.

b) Determine h and calculate if the wooden cylinder in oil as shown in Figure Q2 will float in the position shown.
[h=0.86 m]

c) How could you ensure that the cylinder is stable/unstable on that position? Explain. D = 0.67 m, total height of the cylinder = 1.2 m, SG for wooden cylinder = 0.61 and SG for oil = 0.85.
[GM=-0.137 m]

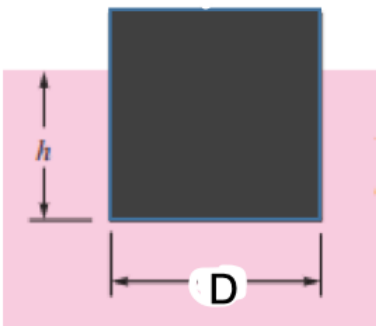

Figure Q2

Question 3

a) State two assumptions before we can apply the Bernoulli's Equation to analyse a flow.

b) Water flows in a pipe thorough an orifice as shown in Figure Q3. Determine the pressure difference before and after the orifice if the height is h = 30 cm.
[P1-P2=40024.8 Pa]

c) Using the continuity and Bernoulli's Equation, determine the flow rate for the flow if d = 2 cm.
[0.002903 m^3/s]
d) What will happen to the height h if d is reduced? Why?

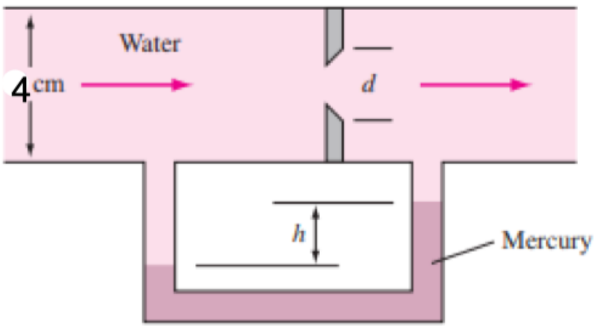

Figure Q3

Question 4

Water flows into a nozzle and exits to the atmosphere.

a) Starting from the Reynolds Transport Theorem, derive the equation for steady flow passing through the nozzle.

b) A fireman holds a hose (diameter of 4 cm) that has a nozzle (diameter of 2 cm) attached to it. If the flow rate of the water is 0.0038 m^3 /s, determine the inlet and outlet velocities of the flow.
[V1=3.02 m/s, V2=12.1 m/s]

c) If there's a leak at the hose, can you still use the equation in (a)? Why or why not?

ASSIGNMENT #1 FOR SEMM2313.

Question 5

A pump increases the water pressure in a pipe (diameter of 20 cm overall) from 200 kPa to 600 kPa. If the outlet is 2 m above the inlet and the constant flow rate is 0.2 m^3 /s, determine the power needed to perform the pumping (pump efficiency is 85%).
[Power=98.72 kW]

Question 6

Water enters steadily into a frictionless, horizontal, 90-degree elbow (inlet diameter of 8 cm) and exits via an attached nozzle (diameter of 4 cm) into the atmosphere. The inlet pressure is 400 kPa.

a) Sketch and label the free body diagram for the problem.

b) Determine the inlet and outlet velocities of the flow.
[V1=7.3025 m/s, V2=29.21 m/s]

c) Starting with the general momentum equations, determine the horizontal force components of the flow onto the elbow.
[Rx=2278.62 N, Ry=1072.007 N]

d) If the nozzle is removed, what will happen to the magnitude of the horizontal force? Why?

Question 7

(a) Starting from the Reynolds Transport Theorem, derive the continuity equation for steady flow for a system with one inlet and two outlets.

(b) Study the flow situation shown in Figure Q7. Using the continuity equation, determine the volumetric flow rate into the tank.
[V_{tank}=0.01536 m/s]

(c) Determine the time taken to fill up the tank from 10 cm to 1 m height.
[t=58.59 s]

(d) If V1 is doubled, determine the time needed to fill up the tank.
[t=11.34 s]

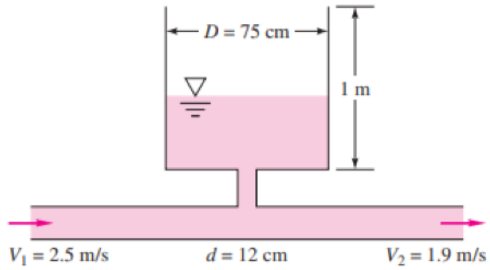

Figure Q7

Question 8

(a) State two factors that can influence the momentum exerted by a moving fluid onto a surface or a body.

(b) In Figure Q8, water flows steadily into the container via opening 1 at 2 m/s and exits via opening 2 (both openings are exposed to atmospheric pressure)
i. Determine the exit velocity (opening 2).
[V2=5.56 m/s]
ii. Determine the horizontal force due to the momentum of the flow.
[Rx=18.51 N, to the left]
iii. Determine the vertical force due to the momentum of the flow.
[Ry=7.12 N, upward]
iv. If water is replaced with oil with S.G. 0.8, discuss on the change of magnitude for (ii) and (iii). Why?

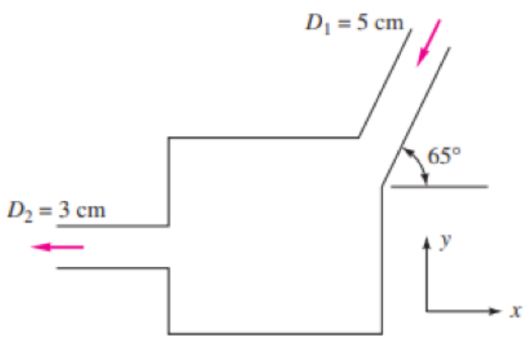

Figure Q8

ASSIGNMENT #1 FOR SEMM2313.

Question 9

(a) The input power, P to a centrifugal pump has been observed to be the function of the density ρ and viscosity μ of the fluid, rotational speed ω, impeller diameter D and volume flow Q. Determine the pi-groups that relates all these functions

$$\left[\pi_1 = \frac{P}{\rho\omega^3 D^5}, \pi_2 = \frac{Q}{\omega D^3}, \pi_3 = \frac{\mu}{\rho\omega D^2}\right]$$

(b) A model pump of ratio 1:5 is to be tested in a laboratory. Determine the recommended rotational speed when the pump is tested in the laboratory with a flow rate 0.3 m^3 /s. What is actual power required if the power used for the model is 100 Watt?

[Power=20 W]

Question 10

Water of density 996.95 kg/m^3 and viscosity 0.903×10^{-3} Ns/m^2 flows in pipes from a lower reservoir to a reservoir that is 12 m higher than the lower one through a globe valve and two standard elbows, driven by a pump as shown in Figure Q10. All components are fitted with screw.

(a) Supported by appropriate calculations, estimate the pump power if the pipe total length and diameter are 25 m and 2.5 cm respectively. The globe valve is fully open causing the water to flow at a flowrate of 0.0022 m^3/s. The pipe is made of special material with 0.017 mm roughness. Refer to appendix for loss coefficients and Moody chart.

(b) Sketch the energy grade line (EGL) and hydraulic grade line (HGL) with appropriate labelling.

(c) Due to the limited space that is available to place the pump, there is a suggestion to relocate the pump closer to the higher reservoir. As an engineer, would you recommend that the pump be placed near a higher reservoir? Justify your answer.

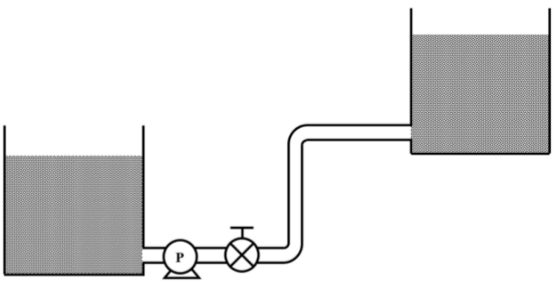

Figure Q10