CE 3305 – Fluid Mechanics Sample Exam 4

Purpose

Demonstrate ability to apply fluid mechanics and **problem solving principles** covering topics such as: Conservation of mass, continunity, conservation of linear momentum, and conservation of energy (modified bernoulli).

Instructions

1. Put your name on each sheet you submit.
2. Use additional sheets as needed.
3. Begin each problem on a separate page. Ok to disassemble to keep pages in order.
4. Do not write on the back of sheets (I won't look)
5. Use the **problem solving protocol** in the class notes. The discussion section can simply be the word "discussion"
6. Label and/or underline answers, be sure to include units.

Allowed Resources

1. Your notes
2. Your textbook
3. The mighty Internet with following proviso
4. **You may not communicate with other people during the exam**

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1. The viscosity of a gas increases with increased temperature because

   A) internal stickiness of the gas decreases.

   B) internal molecular activity decreasess.

   C) internal stickiness of the gas increases.

   D) internal molecular activity increases.

2. Find the difference in pressure between the water and glycerine.

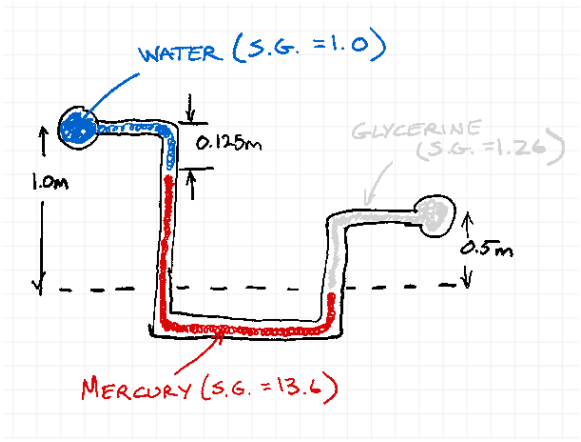

Figure 1:

   A) 35.3 kPa

   B) 42.2 kPa

   C) 55.8 kPa

   D) 110.6 kPa

3. What is the approximate mass of concrete in a 1-meter wide section bounded by FBC

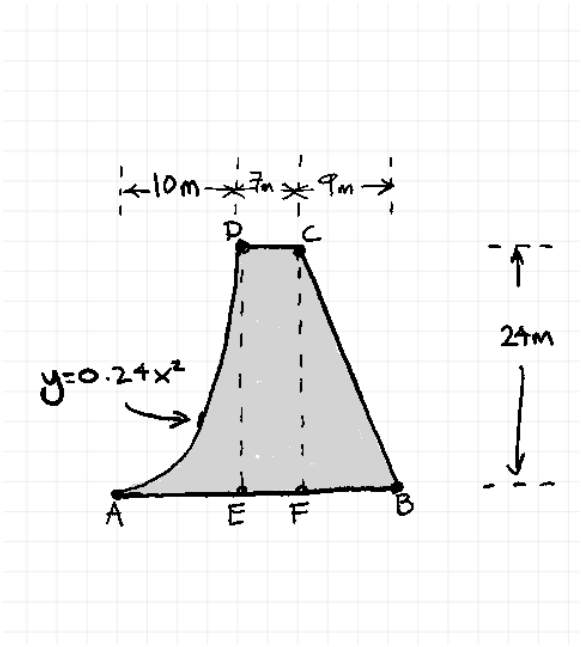

Figure 2:

A) 102,000 Kg

B) 195,000 Kg

C) 226,000 Kg

D) 259,000 Kg

4. What is the approximate mass of concrete in a 1-meter wide section bounded by ADE

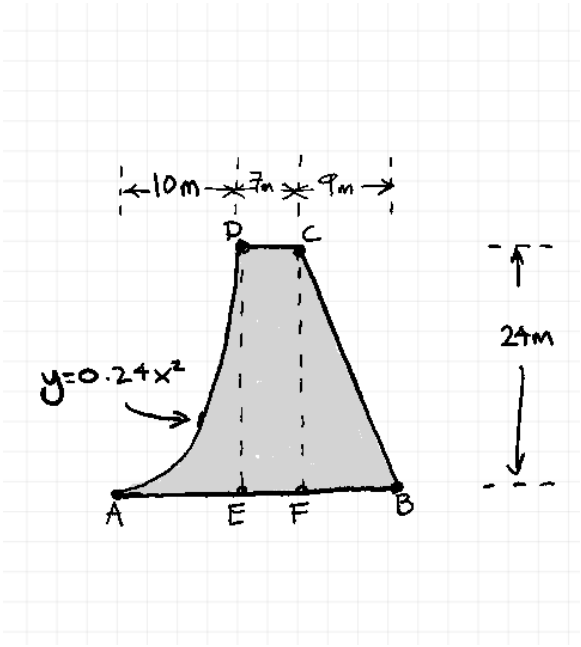

Figure 3:

A) 192,000 Kg

B) 240,000 Kg

C) 288,000 Kg

D) 384,000 Kg

5. What is the resultant force on the inclined wall?.

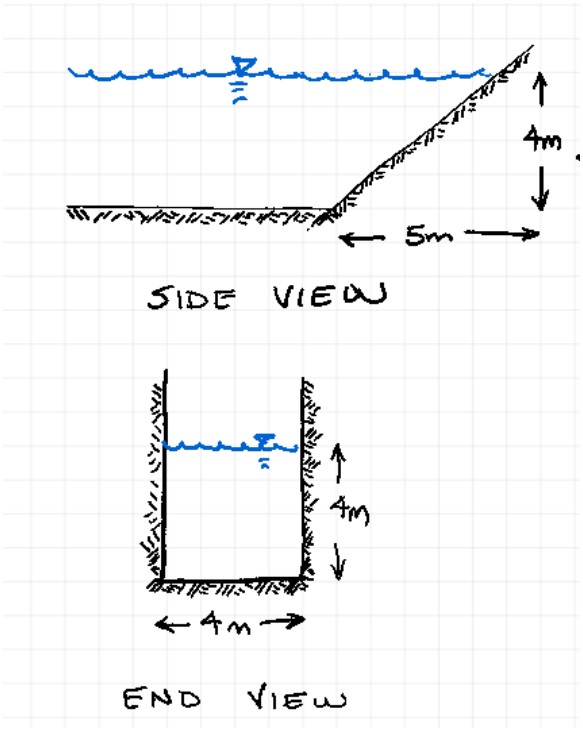

Figure 4:

A) 222 kN

B) 395 kN

C) 503 kN

D) 526 kN

6. What is the vertical force on the inclined wall?.

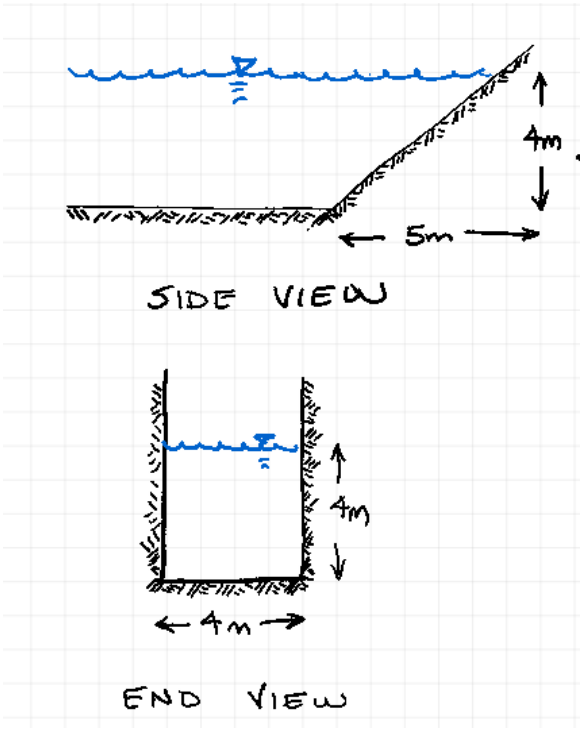

Figure 5:

A) 197 kN

B) 392 kN

C) 486 kN

D) 544 kN

7. What is the horizontal force on the inclined wall?.

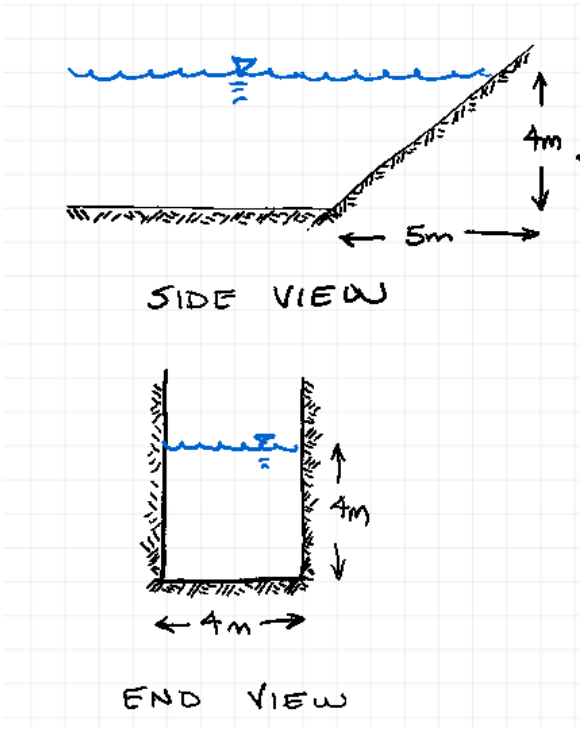

Figure 6:

A) 197 kN

B) 314 kN

C) 421 kN

D) 540 kN

8. The pressure drop over 15 m of 2-cm-diameter galvanized iron pipe is measured to be 60 kPa. If the pipe is horizontal, estimate the flow rate of water. ($\nu = 10^{-6} m^2/s$)

   A) 6.82 L/s

   B) 2.18 L/s

   C) 0.682 L/s

   D) 0.218 L/s

9. Water flows in a pipe of diameter D with a velocity V. It enters at the center of two parallel disks of radius R separated by a distance t. The water flows radially outward between the disks. The velocity with which the water leaves the disks is

   A) $\frac{D^2V}{4R^2}$

   B) $\frac{D^2V}{8Rt}$

   C) $\frac{DtV}{8R^2}$

   D) $\frac{DtV}{4R^2}$

10. What is the energy requirement of an 85% efficient pump that transports 0.04 m^3/s of water if it increases the pressure from 200 kPa to 1200 kPa?

    A) 4.8 kW

    B) 14.2 kW

    C) 34.0 kW

    D) 47.1 kW

11. What is the depth of the center of pressure of the vertical plate if the upper edge is 1.5 meters below the water surface?

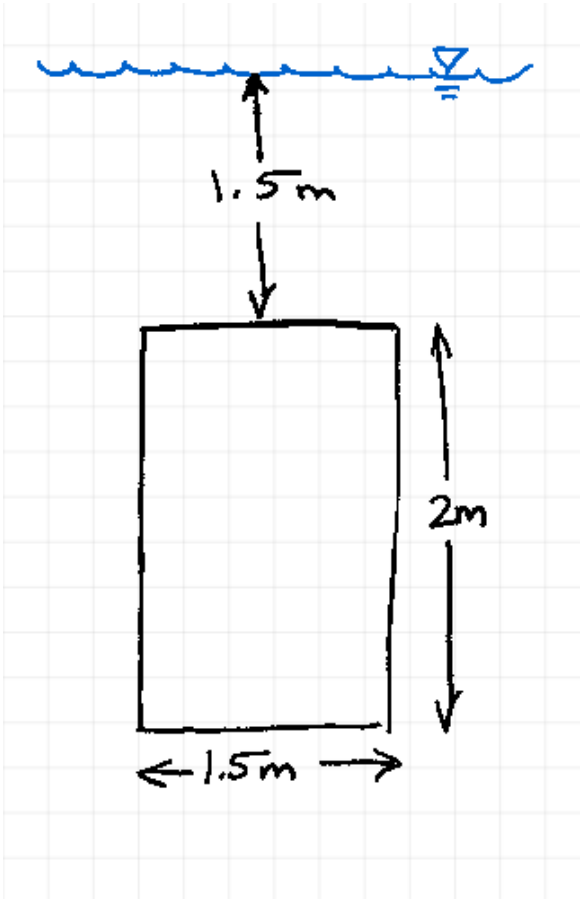

Figure 7:

A) 2.12 m

B) 2.32 m

C) 2.50 m

D) 2.63 m

12. A model of a dam is constructed so the scale of prototype to model is 15:1. The similarity scaling is based on Froude numbers. At a certain point on the spillway of the model, the velocity is measured as 5 meters per second. At the corresponding point on the spillway of the actual (prototype) dam, the velocity is about

    A) 6.7 $\frac{m}{s}$

    B) 7.5 $\frac{m}{s}$

    C) 15 $\frac{m}{s}$

    D) 19 $\frac{m}{s}$

13. The canal shown below is to be widened so that the water flow discharge can be tripled (i.e., flow discharge after widening is three times the initial flow discharge).

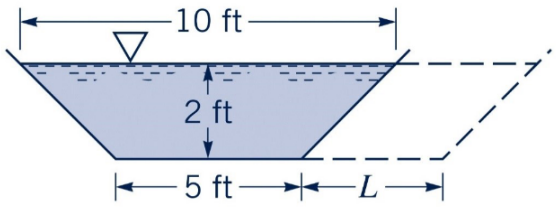

Figure 8:

Determine:

(a) The additional width, L, required if all other parameters (i.e., flow depth, bottom slope, surface material, side slope) are to remain the same

14. The figure below is a schematic of water flowing under a sluice gate in a horizontal channel 5 feet wide.

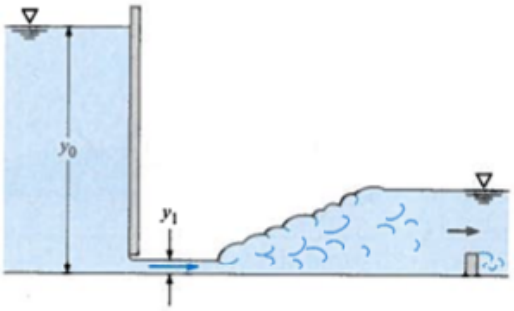

Figure 9:

Determine:

(a) Discharge through the sluice gate

(b) Power dissipated in the jump

(c) The alternate depth (depth of flow after the jump)

15. A simple centrifugal pump consists of a 10-cm disk with radial ports shown. Water is pumped from the reservoir through a central tube coincident with the rotating axis. The disk rotates at 300 rpm and discharges to atmospheric pressure.

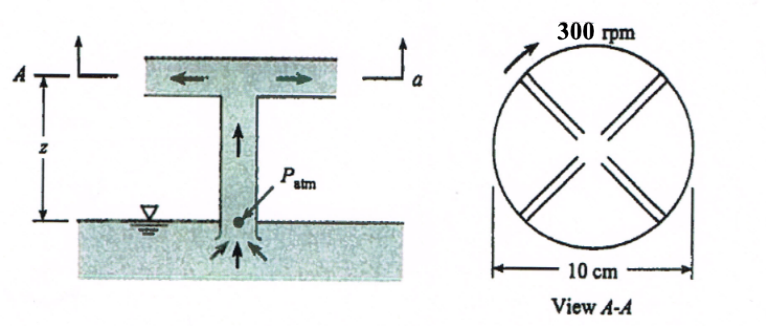

Figure 10:

Determine:

(a) Shutoff height z for the pump.

16. Water flows at a steady rate of 192 $\frac{ft^3}{s}$ through a concrete-lined rectangular channel 16 ft wide as depicted in Figure 1. Water enters the 0.35% sloped channel ($S_0 = 0.0035$) at location 1 and is flowing at 110% normal depth ($1.1 \times y_n$). The water exits over a 3-foot tall weir (assume sharp-crest weir) at location 2.

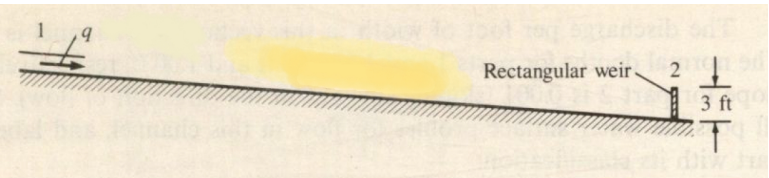

Figure 11:

Determine

(a) Normal depth for the channel.

(b) Critical depth for the channel.

(c) Pool depth just upstream of the weir. (Hint: Add the critical depth to the weir height as an approximation to the pool depth)

(d) An estimate of the distance upstream from the weir to location 1

17. A small spherical drop of water with diameter $d = 4\ mm$ and surface tension ($\sigma = 72.8 \times 10^{-3} \frac{N}{m}$) is depicted in the drawing below.

Figure 12:

Determine:

(a) The gage pressure of the water in the drop.

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18. A windmill is connected directly to a mechanical pump (inertia-type) to lift water from a well that is 10 feet deep as depicted on Figure 5. The wind turbine is a conventional horizontal-axis type with a fan diameter of 10 feet. The efficiency of the mechanical pump is 80%. The pump discharges to atmospheric pressure as shown through 20 feet of 2-inch galvanized pipe.

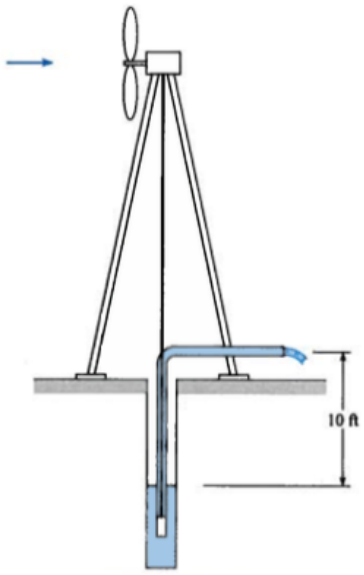

Figure 13:

For an air density $\rho_{air} = 0.07\ \frac{lbm}{ft^3}$ and a wind speed of 30 miles per hour

Determine:

(a) Well discharge in gallons per minute