CE 3305 – Fluid Mechanics 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.
2. Use additional sheets as needed, if you add sheets put your name and the problem number on the added sheet.
3. Use the **problem solving protocol** in the class notes for the fully worked problems (Problems 7-9).
4. 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. Find the difference in pressure between the water and oil in Figure 1 if H = 25 cm.

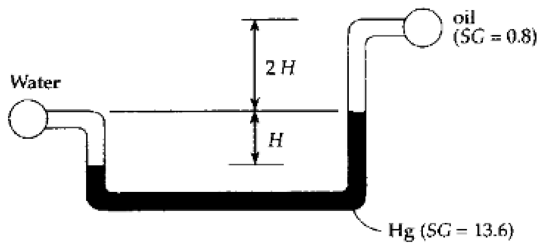

Figure 1:

A) 42.3 kPa

B) 37.2 kPa

C) 34.8 kPa

D) 30.6 kPa

2. The pressure drop across a valve, through which 0.04 m^3/s of water flows, is measured to be 100 kPa. Estimate the loss coefficient if the nominal diameter of the valve is 8 cm.

   A) 0.32

   B) 0.79

   C) 3.2

   D) 8.7

3. Find the expression for the force P needed to hold the gate of width w in the position shown.

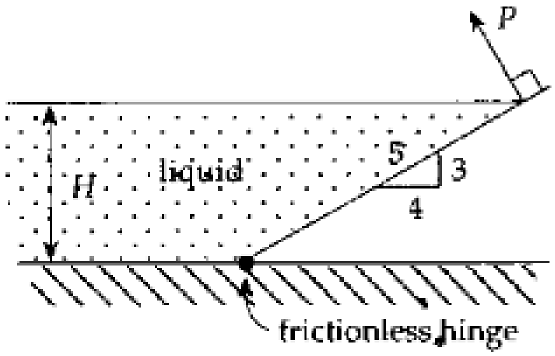

Figure 2:

A) $\frac{5}{18}\gamma w H^2$

B) $\frac{1}{6}\gamma w H^2$

C) $\frac{2}{9}\gamma w H^2$

D) $\frac{1}{2}\gamma w H^2$

4. 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

5. Water flows through a converging fitting shown and discharges to the atmosphere as a free jet. Flow is incompressible, friction negligible.

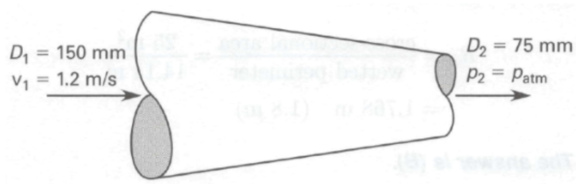

Figure 3:

The gage pressure at the inlet is

A) 10.2 kPa

B) 10.8 kPa

C) 11.3 kPa

D) 12.7 kPa

6. 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 $\frac{m}{s}$

7. 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).

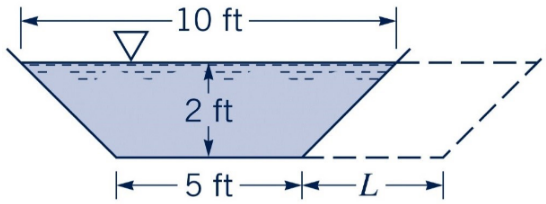

Figure 4: Cross section of trapezoidal channel

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

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

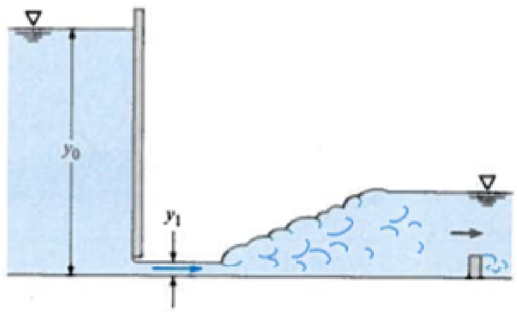

Figure 5: Supercritical flow under a sluice gate

Determine:

(a) Discharge through the sluice gate

(b) Power dissipated in the jump

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

9. Figure 6 is a gravity-flow pipe network with water supplied from a fixed-grade reservoir (pool elevation 100 meters) connected to node N2. All pipes are ductile iron.

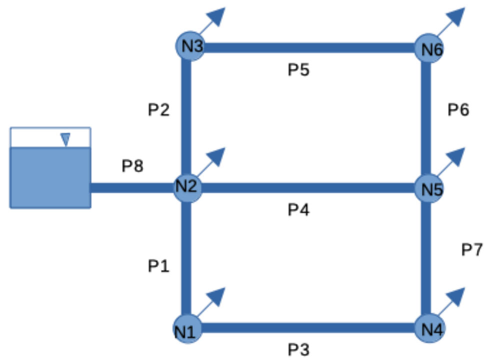

Figure 6: Gravity flow pipe network

The pipe dimensions and node demands are shown in the tables below.

Pipe ID	Length(m)	Diameter(mm)	Friction factor f
1	1,220	254	0.028
2	1,829	254	0.028
3	1,829	305	0.028
4	1,982	610	0.028
5	2,134	254	0.028
6	915	457	0.028
7	1,524	254	0.028
8	91	305	0.028

Node ID	Elevation(m)	Demand(liters/sec)
N1	51.8	0.0
N2	54.9	0.0
N3	50.3	0.0
N4	47.3	0.0
N5	45.7	181.3
N6	44.2	0.0

Determine:

(a) The flow rate (and direction of flow) for each pipe in the network, for the case where the total head at the supply reservoir is 100 meters.

(b) The resultant pressure in SI units at each node.

(c) The Darcy-Weisbach friction factor for each ductile iron pipe of the network.

(d) The head loss from Node 2 to Node 6.

(e) The node with the lowest pressure.