CE 3305 – Fluid Mechanics Exam 2

Purpose

Demonstrate ability to apply fluid mechanics and problem solving principles covering topics such as: Dimensional analysis and similitude; turbulent flow in closed conduits; pump system performance.

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 the exam to keep pages in order.
4. Do not write on the back of sheets (I don'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. Flow around a bridge pier is studied using a $\frac{1}{12}$ scale model. The approach velocity in the model is 0.9 $\frac{m}{s}$ and at this speed the standing wave at the bridge pier nose is measured to be 2.5 cm in height (above the undisturbed water surface).

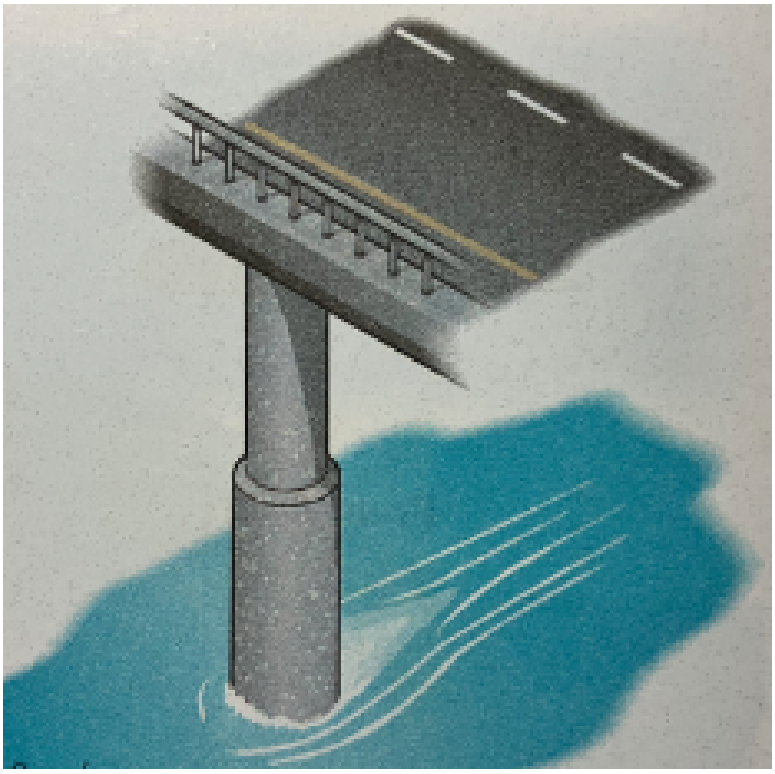

Figure 1:

Determine:

(a) The approach velocity in the prototype using Froude number matching ($Fr = \frac{V}{\sqrt{L}}$).

(b) The wave height in the prototype.

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2. A smooth pipe designed to carry crude oil is to be modeled with a smooth pipe 0.75 inches in diameter carrying water (T =60^{o}F). The protoype properties are:

   - $D = 47$ inches
   - $\rho = 1.75$ slugs/ft^3
   - $\mu = 4 \times 10^{-4}$ $\frac{lbf\ s}{ft^2}$

   Determine:

   (a) The mean velocity of the water in the model to ensure dynamically similar conditions, if the mean velocity in the prototype is to be 2 ft/s,?

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3. In the design of a lift station, a bypass line is often installed parallel to the pump so some liquid recirculates as shown on Figure 1. The bypass valve then controls the flow rate in the system.

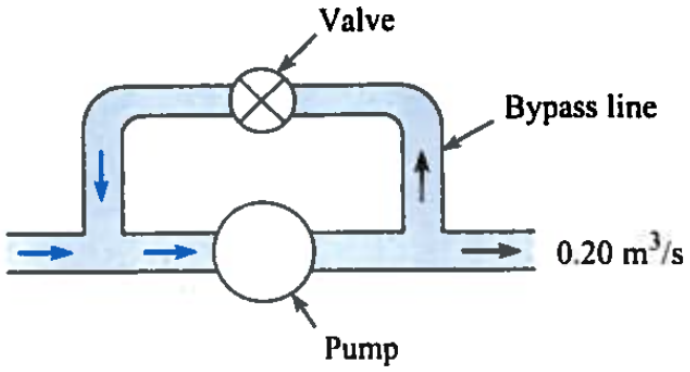

Figure 2:

The pump performance function is

$$h_p = 100 - 100Q$$

¡br¿where h_p is in meters, and Q is in $\frac{m^3}{sec}$. The bypass line is 10 cm in diameter. The valve setting produces a loss coefficient of $K = 0.2$ and the valve loss is the only meaningful head loss at the lift station.

For a discharge leaving the lift station of 0.2 $\frac{m^3}{sec}$

Determine:

(a) The discharge through the pump

(b) The discharge through the bypass line
