FLUID MECHANICS I   ENGINEERING 4913

FINAL EXAM   4 AUGUST 2009   2PM TO 5PM

INSTRUCTOR: HINCHEY

NAME : ______________________________

THE MARKS FOR EACH QUESTION ARE GIVEN BELOW. PART MARKS ARE GIVEN IN SQUARE BRACKETS AFTER EACH PART.

TRUE OR FALSE QUESTION   10%

HYDRAULIC GATE QUESTION   10%

METACENTER QUESTION   10%

ENERGY QUESTION   35%

MOMENTUM QUESTION   20%

SCALING QUESTION   15%

TOTAL MARKS   100%

Give a TRUE or FALSE response to each of the following and briefly explain each answer:

Eddy viscosity is a property of fluids. [1]

Mach Number is important for low speed flows. [1]

A pitot tube is used to measure temperature. [1]

Flows inside pipes are usually laminar. [1]

Boundary layer separation causes drag. [1]

Froude Number is important for float planes. [1]

Net flow into a junction must be positive. [1]

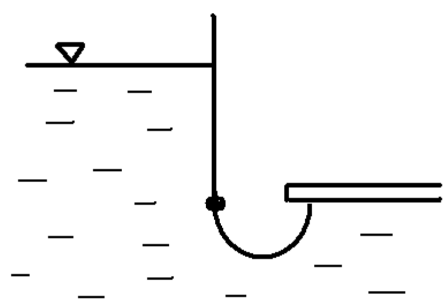
Net head loss for a loop must be negative. [1]

Pump efficiency is very low at a BOP. [1]

NPSH is used to pick pump type. [1]

A 2D hydraulic gate is shown in the sketch below. It has a vertical section on the left side and a semicircular section on the bottom. The semicircle has a radius R=1m. There is a pivot where the two sections of the gate join. Let the submergence depth to the pivot be h.

Determine the value of h that would make the gate open. For this assume that the weight of the gate is insignificant. [10]



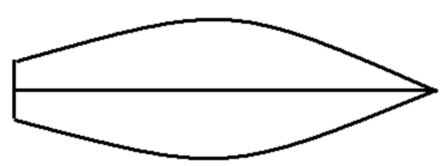
A catamaran barge has 2 rectangular legs. The legs are 2R wide. The leg spacing is 2H. The legs are 2G long. The K and V for the legs are:

$$K = 2\ [2G\ 2\ R^3/3\ \ +\ 2G\ H^2\ 2\ R]$$

$$V = 2\ 2R\ 2G\ h$$

where h is the submergence depth or the distance from the water line to the bottom of the legs.

A boat can be approximated by a number of catamarans butted up against each other. The boat shown in the schematic below has vertical sides and a flat bottom. It is 5m long and 2m wide. Its submergence depth is 0.25m. Approximate the boat using 2 catamarans and estimate the location of its metacenter relative to the water line. [10]



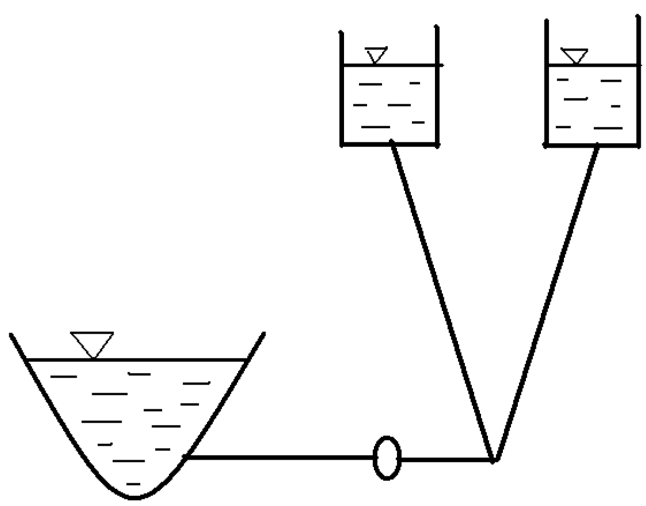
The pipe network shown in the sketch below consists of 3 pipes and 3 water reservoirs open to atmosphere. The height from the lower reservoir to the two upper reservoirs is 100m. The resistance of the pipe connected to the lower reservoir is R=7500 s^2/m^5. Each of the pipes going to the upper reservoirs has resistance R=10000 s^2/m^5.

Determine an equivalent resistance for the two pipes going up to the upper reservoirs. [10]

Determine the pump power required to pump a volumetric flow rate of $0.01m^3/s$ from the lower reservoir to the upper reservoirs. [15]

How would you determine the friction factor for each pipe and also its roughness? Assume that all geometry is known except for roughness. [5]

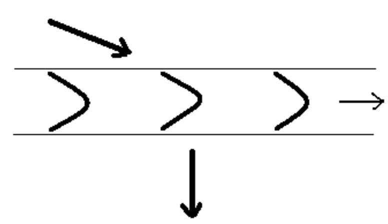
How would you determine the pump power when the upper reservoirs are at different levels and the pipes leading to them have different R values? [5]



In a dentist drill, compressed air jets are used to operate a small air motor in the tip of the drill. The motor operates very much like a Pelton Wheel Turbine. The power absorbed by the motor is used to provide a grinding action. The jet diameter is 0.5mm. The jet angle is 10°. There are 10 jets. The density of the air is approximately 1 kg/m^3. The rotational speed of the motor is 100000 RPM. The rotor diameter is 8mm. The peak power occurs when the speed of the rotor blades is half the tangential component of the jet speed. For the peak power case the tangential speed out is zero. Both questions below are for the peak power case.

Determine the mass flow rate into the motor. [10]

Determine the power absorbed by the motor. [10]



A skydiver falls under gravity and reaches a terminal speed where weight is balanced by wake drag. A certain diver has a mass of 75kg, a drag coefficient of 0.9 and a profile area 0.5m^2.

What would be the terminal speed of the diver? [5] For this let the density of air be 1 kg/m^3.

What would be the speed of a 1:2 scale model? [5]

What would be the mass of a 1:2 scale model? [5]