CVEN 311-501 “Fluid Dynamics”

H O M E W O R K  8

Due Friday, 11/2/2012 at 8:00 AM
(No late papers accepted without documented university excuse)

PART I – Optional textbook problems. Do not turn these problems in with your assignment.

Application of the Energy Equation
1. Textbook problem 5.100, pg. 269 (6th ed.: 5.92, pg. 256)

Application of the Energy Equation – Combined with Linear Momentum
PART II – Required problems. You must turn these problems in with your assignment. Problem 1 will be graded on effort alone. Problem 2 will be graded based on accuracy.

1. {From Fall 2010 Midterm 2} A personal watercraft (PWC, a.k.a., “Sea-Doo” or “Jet Ski”) propels itself by use of an axial flow pump (see Figure 3-1). Water enters the pump through an inlet grate on the underside of the PWC hull, flows through a spinning axial flow impeller (that performs shaft work), and exits out a nozzle at the rear of the PWC.

![Figure 3-1](image)

Details for a typical PWC propulsion system are shown in Figure 3-2 (the impeller and driveshaft are omitted). The velocity of the inflow is equal to the speed that the PWC is traveling through the water.

![Figure 3-2](image)

A PWC has a 70 hp engine, and its overall efficiency for the engine, driveshaft, and impeller is 67%. All other head losses can be considered negligible. If the PWC is traveling at 30 mi/hr in freshwater:

(A) What is the reactive force generated by change in momentum flux in the propulsion unit?

(B) What is the reactive force generated by increased pressure at the outlet nozzle?

(C) What is the total propulsive force (i.e., sum of the two forces above)?
2. {From Fall 2011 Midterm 2} A large pump is installed in a pump station by anchoring it to the station’s concrete slab floor with several bolts. The pump has an inflow pipe diameter of 12 inches and an outflow pipe diameter of 10 inches. The pump operates at a power consumption of 440 kW and gross efficiency of 54%. Flowrate through the pump is 4000 gal/min, and the fluid being pumped is water. Static pressure at the pump inflow is 37.8 psi.

What is the total shearing force (lb) that the anchor bolts must bear?