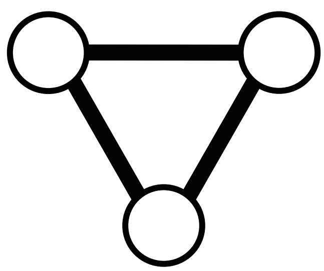
13.012 Marine Hydrodynamics for Ocean Engineers
Prof. Alex Techet
Fall 2004

HW #2
Out: 21 Sept 2004
Due: 28 Sept 2004

Problem 1: Hydrostatics

An AUV is designed as shown below. It has three, hollow, cylindrical canisters arranged in an upside down triangle. The cylindrical canisters are constructed out of aluminum, specific gravity of 2.7, and have a wall thickness of 0.5 cm, length 1.25 meters, and an inner diameter 15.25 cm. What is the maximum weight (kg) this vehicle can carry without requiring additional flotation to avoid sinking, ignoring the additional weight and buoyancy of the struts. (Think neutrally buoyant!) Assume the vehicle will be operating in SALT water ($\rho = 1025\ kg/m^3$).



AUV Design.

Problem 2: Basic Fluids

a) The two common ways of describing fluid flow are the ___________ and the _____________ descriptions.

b) Although fluids, such as water, are really made up of discreet molecules, we are able to describe their behavior by differential equations by virtue of a ___________ hypothesis.

Problem 2: Basic Fluids (con't)

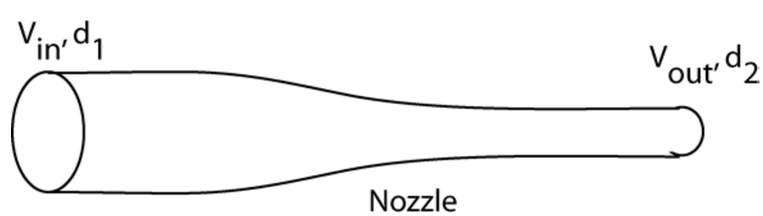
c) Discuss the difference between a pathline and a streamline. Under what conditions are they the same?

d) Dye is injected into a flow at a given point. In steady flow, the locus of all dyed particles forms a [pathline] [streamline] [streakline] [none of the above]. In unsteady flow, the locus of all dyed particles forms a [pathline] [streamline] [streakline] [none of the above].

Problem 3:

Flow through a certain garden hose exits at 1 m/s. The hose has an inside diameter of 2.5 cm. In order to wash the barnacles off of your boat hull you need a higher velocity coming out of the hose, so you attach a nozzle to the end of the hose to change the outlet diameter. In order to obtain an exit velocity of 1.5 m/s what should the diameter of the nozzle be at the outlet?

**Assume incompressible flow and that the pressure remains constant across the nozzle, and that the flow is constant across the inlet and outlet cross-section.



Problem 4:

The largest artery in the body is the one that supplies blood to the legs. As it comes down the body it splits into a Y-junction, as shown in the figure below. Blood with specific gravity of 1.05 is pumped into the junction at speed V_1= 1.5 m/s. The diameter of the entrance is d_1=20 mm. The two branches have diameter d_2 = 15 mm and d_3 = 12 mm. If the mass flow rates at stations 2 and 3 are equal, find the velocities V_2 and V_3.

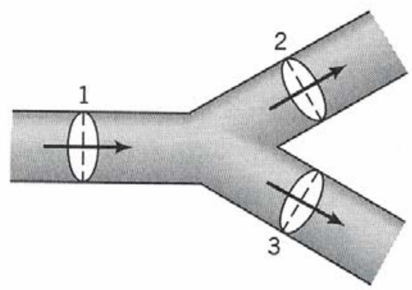
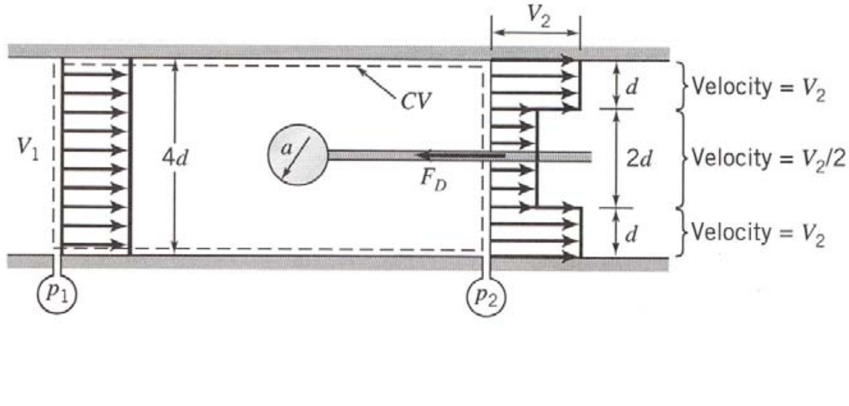


FIGURE P3.12

Problem 5:

Using Control Volume shown below, determine the force, F_D, acting on the cylinder by the fluid, using mass and momentum balances.

Hint: Integrate the inflow and outflow quantities for mass and momentum over the inlet and outlet. There is no flow in the vertical direction and the fluid is incompressible. Assume that pressure at the inlet, p_1, and at the outlet, p_2, are the same.

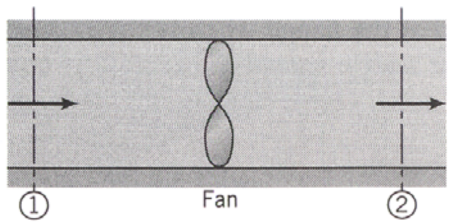


Problem 6:

a) Write down Bernoulli's Equation for steady flow.

b) Under what conditions does this equation hold?

Fluid passes through a fan placed in a constant diameter duct shown in the figure below. Assume the density is constant.



c) Is the volume flow rate at station 1, the same as at station 2? Why?

d) Can Bernoulli's equation be applied between stations 1 and 2? Why?