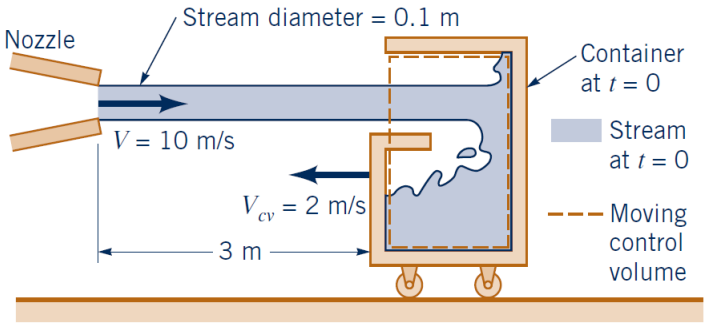
Homework set 8

Due: 2:10 PM – October 26, 2018

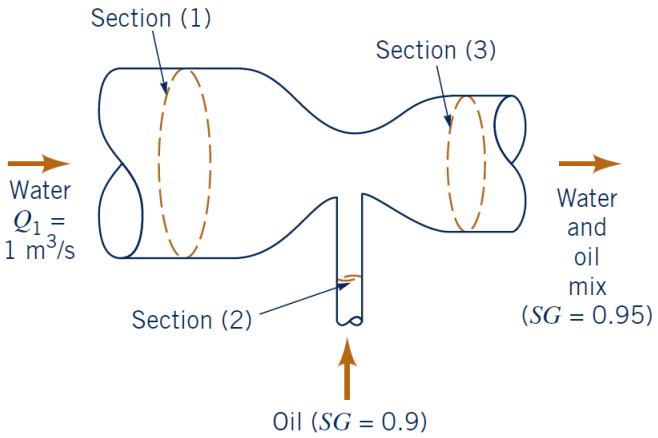
Problem 1

Water flows from a nozzle with a speed of $V = 10$ m/s and is collected in a container that moves toward the nozzle with a speed of $V_{cv} = 2$ m/s as shown in the figure below. The moving control surface consists of the inner surface of the container. The system consists of the water in the container at time $t = 0$ and the water between the nozzle and the tank in the constant diameter stream at $t = 0$. At time $t = 0.1$ s what volume of the system remains outside of the control volume? How much water has entered the control volume during this time period? Repeat the problem for $t = 0.3$ s.



Problem 2

Oil having a specific gravity of 0.9 is pumped as illustrated in the figure with a water jet pump. The water volume flowrate is 1 m^3/s. The water and oil mixture has an average specific gravity of 0.95. Calculate the rate, in m^3/s, at which the pump moves oil.

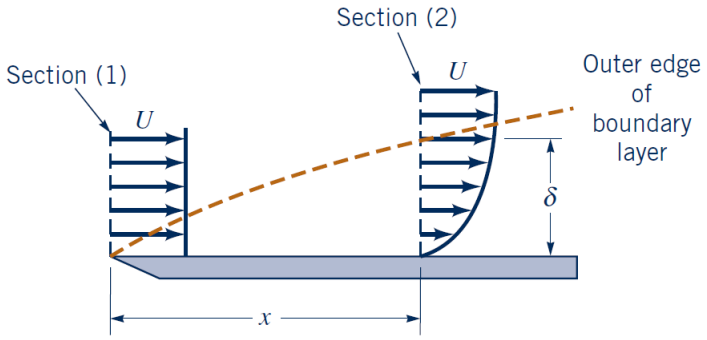


Problem 3

Flow of a viscous fluid over a flat plate surface results in the development of a region of reduced velocity adjacent to the wetted surface as depicted in the figure. This region of reduced flow is called a boundary layer. At the leading edge of the plate, the velocity profile may be considered uniformly distributed with a value U. All along the outer edge of the boundary layer, the fluid velocity component parallel to the plate surface is also U. If the x-direction velocity profile at section (2) is:

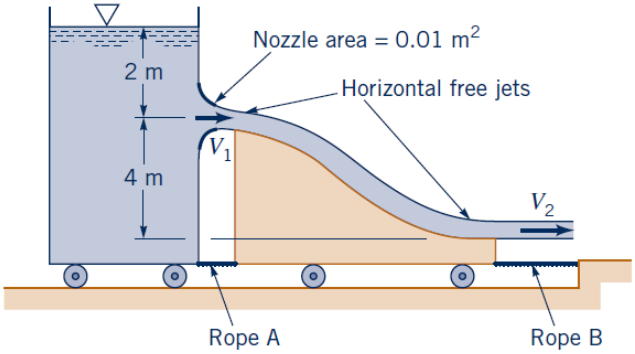
$$\frac{u}{U} = (\frac{y}{\delta})^{1/7}$$

develop an expression for the volume flowrate through the edge of the boundary layer from the leading edge to a location downstream at x where the boundary layer thickness is δ. Assume the width of the plate is L.



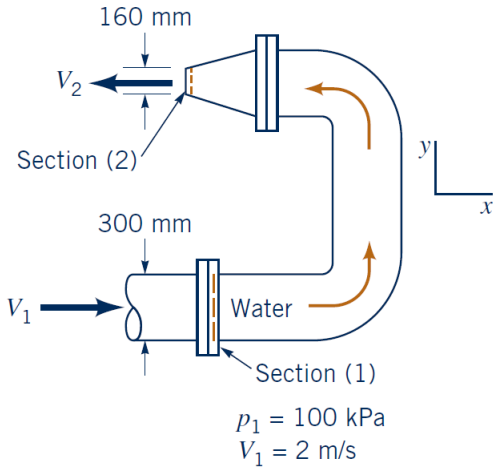
Problem 4

Water flows steadily from a tank mounted on a cart as shown in the figure below. After the water jet leaves the nozzle of the tank, it falls and strikes a vane attached to another cart. The cart's wheels are frictionless, and the fluid is inviscid. (a) Determine the speed of the water leaving the tank, V_1, and the water speed leaving the cart, V_2. (b) Determine the tension in rope A. (c) Determine the tension in rope B.



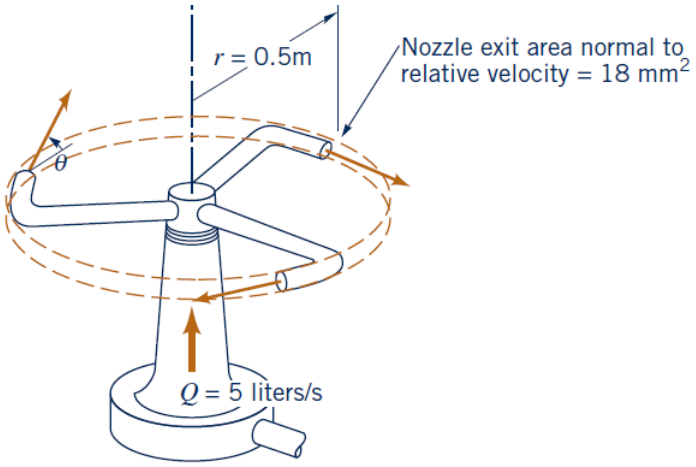
Problem 5

Determine the magnitude and direction of the anchoring force needed to hold the horizontal elbow and nozzle combination shown in the figure in place. Atmospheric pressure is 100 kPa (absolute pressure). The gage pressure at section (1) is 100 kPa. At section (2), the water exits to the atmosphere.



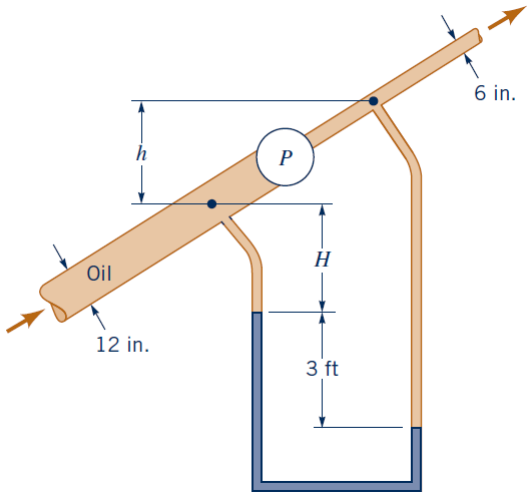
Problem 6

Five liters/s of water enter the rotor shown in the figure, along the axis of rotation. The cross-sectional area of each of the three nozzle exits normal to the relative velocity is 18 mm^2. How large is the resisting torque required to hold the rotor stationary? How fast will the rotor spin steadily if the resisting torque is reduced to zero and (a) $\theta = 0^o$, (b) $\theta = 30^o$, (c) $\theta = 60^o$?



Problem 7

Oil (SG=0.88) flows in an inclined pipe at a rate of 5 ft^3/s as shown in the figure below. If the differential reading in the mercury manometer is 3 ft, calculate the power that the pump supplies to the oil if head losses are negligible.



TEXTBOOK

Munson, B.R., Okiishi, T.H., Huebsch, W.W., and Rothmayer, A.P., "Fundamentals of Fluid Mechanics", 7th Edition, 2013, John Wiley & Sons.