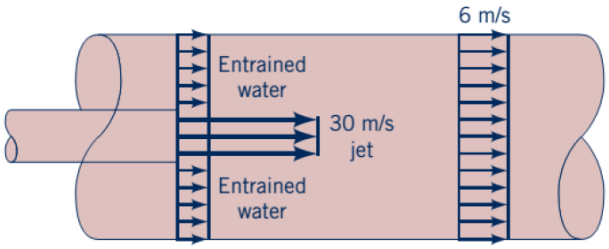
October 19, 2023

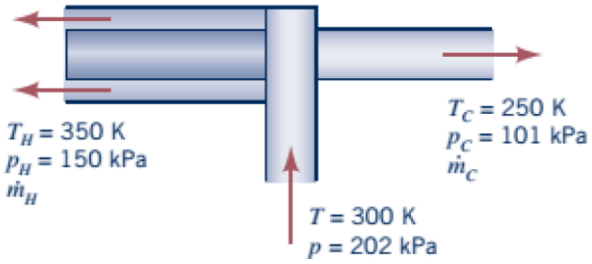
Mechanical, Automotive and Materials Engineering
Fluid Mechanics I
MECH3233-F23
Assignment Problems Set #5

Due: Wednesday, October 25, 2023, at 11:59 p.m.

Problem 1 (3 points): A water jet pump (see the figure below) involves a jet cross-sectional area of 0.01 m^2, and a jet velocity of 30 m/s. The jet is surrounded by entrained water. The total cross-sectional area associated with the jet and entrained streams is 0.075 m^2. These two fluid streams leave the pump thoroughly mixed with an average velocity of 6 m/s through a cross-sectional area of 0.075 m^2. Determine the pumping rate (i.e., the entrained fluid flowrate) involved.

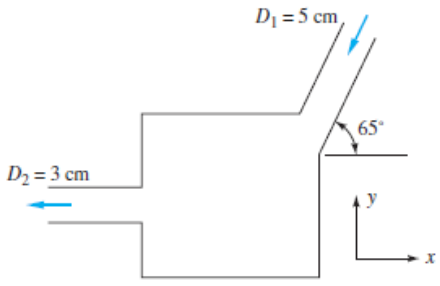


Problem 2 (3 points): In the vortex tube shown below, air enters at 202 kPa absolute and 300 K. Hot air leaves at 150 kPa absolute and 350 K, whereas cold air leaves at 101 kPa absolute and 250 K. The hot air mass flow rate, $\dot{m}_H$, equals the cold air mass flow rate, $\dot{m}_C$. Find the ratio of the hot air exit area to cold air exit area for equal exit velocities.



Hint: Assume the air is an ideal gas.

Problem 3 (4 points): Water at 20°C flows steadily through the mixing chamber shown below entering station (1) at 2 m/s. Calculate the (a) horizontal; and (b) vertical forces required to hold the box stationary against the flow momentum.



Problem 4 (5 points): Water at 20°C flows through the elbow (see figure below) and exits to the atmosphere. The pipe diameter is D_1 = 10 cm, while D_2 = 3 cm. At a weight flow rate of 150 N/s, the pressure p_1 = 2.3 atm (gage). Neglecting the weight of water and elbow, estimate the force on the flange bolts at section 1.