

AME 20231

Homework 7

Due: Friday, 8 March 2013, in class

1. 6.16, instead, let the exit pressure be 115 kPa .
2. Consider flow in a pipe with constant cross-sectional area A . Flow enters a fixed control volume at the inlet i and exits at the exit e . The velocity in the x direction is \mathbf{v} . Derive the control volume version of the linear x -momentum equation for a fluid in a fashion similar to that used in lecture for the mass and energy equations. The only force you need to consider is a pressure force; neglect all wall shear forces and gravity forces. The final form should be of the form

$$\frac{d}{dt} \int_V \rho \mathbf{v} dV = \dot{m}_i \mathbf{v}_i - \dot{m}_e \mathbf{v}_e + P_i A - P_e A.$$

You may wish to consult any of a variety of undergraduate fluid mechanics textbooks for more guidance.

3. 6.33, instead, let the final pressure be 80 kPa .
4. 6.59, instead let the flow rate be 0.04 kg/s
5. Take data from Table A.8 for N_2 and develop your own third order polynomial curve fit for $u(T)$. That is find a_1, a_2, a_3 such that

$$u(T) \sim a_0 + a_1 T + a_2 T^2 + a_3 T^3$$

well describes the data in the range $200 \text{ K} < T < 3000 \text{ K}$. Give a plot which gives the predictions of your curve fit $u(T)$ as a continuous curve for $200 \text{ K} < T < 3000 \text{ K}$. Superpose on this plot discrete points of the actual data. Take an appropriate derivative of the curve fit for $u(T)$ to estimate $c_v(T)$. Give a plot which gives your curve fit prediction of $c_v(T)$ for $200 \text{ K} < T < 3000 \text{ K}$. Superpose discrete estimates from a simple finite difference model $c_v \sim \frac{\Delta u}{\Delta T}$, where the finite difference estimates come from the data in Table A.8, onto your plot. You will find a discussion on least squares curve fitting in the online course notes to be useful for this exercise.