AME 20231
Homework 7
Due: Friday, 5 March 2010, in class

1. 6.16

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 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

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

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

3. 6.33

4. 6.59

5. 6.158E

6. 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 $200\ K < T < 3000\ K$. Give a plot which gives the predictions of your curve fit $u(T)$ as a continuous curve for $200\ K < T < 3000\ K$. 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 $200\ K < T < 3000\ K$. 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.