ME 456
Prof. J. M. Powers
Homework 4
Due: Friday, 26 February 1999

1. Using at least two references, write a document of less than one page describing engine knock. Cite all references. Use the LaTeX text processor. Post your report on the world wide web as a pdf file. Also give me a hardcopy.

2. Consider an eight species, thirty-seven reaction mechanism for the combustion of H_2 with O_2 as found in the first thirty-seven reactions listed by Maas and Pope[1] in their Table 1. Couple this with the Zeldovich mechanism for formation of NO as done in an earlier homework. Consider combustion in a volume which is initially a cube, whose side is of length 200 mm, of a gas which has initial mole fractions of $X_{H_2} = 0.2$, $X_{O_2} = 0.2$, $X_{N_2} = 0.6$, and an initial pressure and temperature of 1 MPa and 1000 K,

   (a) For adiabatic, isochoric combustion, determine the variation of all species concentrations, temperature, and pressure as functions of time; give computer-generated plots on logarithmic scales; plot all species concentrations on a single plot. Put all plots on a single page.

   (b) Repeat the previous problem if there is lumped heat transfer from the volume to the surroundings. Take the heat transfer coefficient to be $h = 10\, W/m^2/K$ and the far field temperature to be 300 K.

   Use the thermochemical calculator to develop linear estimates for the thermal equation of state for each species.

3. Using the thermochemical calculator, and referring to Section 4.10 of Warnatz's text, make a plot of $\overline{c}_v$ as a function of T for 200 $K < T <$ 3000 K. Give a brief handwritten explanation for the variation of $\overline{c}_v$ based on molecular phenomena.

[1] Maas, U. and Pope, S. B., 1992, "Simplifying Chemical Kinetics: Intrinsic Low-Dimensional Manifolds in Composition Space," *Combustion and Flame*, Vol. 88, pp. 239-264.