AME 598i
Prof. J. M. Powers
Homework 11
Due: Wednesday 16 April 2003

Consider the reactive Euler equations for a calorically perfect ideal gas as developed in class with $\gamma = \frac{7}{5}, q = 1.0 \times 10^6 \ \frac{J}{kg}, R = 287 \ \frac{J}{kg \ K}, P_o = 1 \times 10^5 \ Pa, T_o = 300 \ K, E = 1.0 \times 10^6 \ \frac{J}{kg}$.

- If $D = 3000 \ \frac{m}{s}$, find the pressure at N, S, and W.
- Find D_{CJ}, P_{CJ}, ρ_{CJ}, and T_{CJ} for both Chapman-Jouguet detonation and deflagration.
- Give a computer-generated plot of the complete reaction Hugoniot, the inert Hugoniot, and Rayleigh lines for $D = D_{CJ}$ and $D = 3000 \ \frac{m}{s}$
- Give a computer generated plot of the wave speed D as a function of the laboratory frame complete reaction velocity $u(\lambda = 1)$.
- Plot $P(\xi)$, $u(\xi)$, and $M(\xi)$ for two wavespeeds: $D = D_{CJ}$ (detonation branch) and $D = 3000 \ \frac{m}{s}$. For the Mach number plots, take the Mach number to be defined in the steady wave frame. Take as a kinetics model

$$\hat{u}\frac{d\lambda}{d\xi} = k(1-\lambda)\exp\left(-\frac{E}{RT}\right)$$

with $k = 1 \times 10^8 \ s^{-1}$.

Give all supporting analysis. You may use any point in the course notes as a starting point, or you may want to give a complete development for your own benefit. You will likely need to use either a Fortran or Maple/Mathematica program to complete the analysis.