ME 456
Prof. J. M. Powers
Homework 8
Due: Wednesday, 7 April 1999

1. Consider a slab of the solid energetic material LX-14 (a common explosive). The slab has length $L = 0.25\ m$. Assume the LX-14 has material properties as given by Powers [1], with the following exceptions, which we take to avoid problems of numerical convergence, $a = 5 \times 10^{-5}\ s^{-1}, E = 2.206 \times 10^4\ J/mol$. Solve the Frank-Kamenetskii problem for this scenario. Assume the temperature at the outer radius is held fixed at $300\ K$ and the temperature evolution is governed by the following differential equation as developed in lecture:

$$\frac{\partial T}{\partial t} = \frac{1}{D}\frac{\partial}{\partial x}\left(\frac{\partial T}{\partial x}\right) + (1-T)\exp\left(\frac{-\Theta}{1+QT}\right).$$

   (a) Use a numerical shooting technique to solve for the temperature distribution $T(x)$ in the limit of steady state.

   (b) Use a one term collocation technique to estimate the temperature distribution $T(x)$. Compare with your result from the shooting technique.

   (c) Holding other parameters fixed, vary D and plot $T(x = 0)$ as a function of D.

   (d) Find the critical slab length below which small temperature solutions may exist.

   (e) (optional) Use the technique developed in class to find the stability of the low temperature solution.

[1] Powers, J. M., 1999, "Thermal explosion theory for shear localizing energetic solids," *Combustion Theory and Modelling*, Vol. 3, pp. 103-122.