AME 598t
Prof. J. M. Powers
Homework 8
Due: Thursday, 31 March 2005

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:

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

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

   (b) Holding other parameters fixed, vary $\mathcal{D}$ and plot $T(x = 0)$ as a function of D.

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

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