AME 60636
Prof. J. M. Powers
Homework 8
Due: Friday, 27 March 2009

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, $a = 5 \times 10^{-5}\ s^{-1}, \overline{E} = 2.206 \times 10^4\ J/mol$. 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.

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