AME 60636
Prof. J. M. Powers
Homework 10
Due: Monday, 13 November 2006

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, $a = 5 \times 10^{-5}\ s^{-1}, E = 2.206 \times 10^4\ J/mol$. Consider 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 an appropriate numerical technique such as the method of lines to solve the full unsteady initial value problem if $T(x, 0) = 300\ K$. Comment on whether the time scales of relaxation compare well with those determined from your linear stability analysis.

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