ME 456
Prof. J. M. Powers
Homework 7
Due: Friday, 26 March 1999

1. Consider a 3 kg sphere of the solid energetic material LX-14 (a common explosive). Assume the LX-14 has its material properties as given by Powers [1]. Solve the Frank-Kamenetskii problem for this scenario. Assume the temperature at the outer radius is held fixed at 500 K and the temperature evolution is governed by the following differential equation as developed in lecture:

$$\frac{\partial T}{\partial t} = \frac{1}{D}\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial T}{\partial r}\right) + (1-T)\exp\left(\frac{-\Theta}{1+QT}\right).$$

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

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

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

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

2. Write a one page maximum description of the famous 1947 Texas City explosion. Include a discussion of thermal explosion theory. Cite all sources. Post your paper on the web.

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