ENGINEERING PHYSICS 4D3 **Assignment #4** Set:
Due:

Consider a 120cm wide slab of Pu^{239} with the following characteristics:
$\sigma_f = 1.85$ b $\sigma_a = 2.11$ b $\sigma_{tr} = 6.8$ b $\nu = 2.98$ $\eta = 2.61$
$N(Pu^{239}) = 0.00395 \times 10^{24}$

1. Analytical approach.
   a. Calculate the effective k value for the geometry and material composition. Classify this setup as subcritical, critical, or supercritical.
   b. Analytically determine and plot the SS flux distribution for the critical case (solution given in text).

2. Numerical approach.
   a.. Numerically determine and plot the SS flux distribution for the critical case using the Gauss Siedel or SOR method.
   Use the following error criterions for flux and k:

$$flux\ error = \frac{\sum_{i=1}^{\#\,nodes} flux^{new} - \sum_{i=1}^{\#\,nodes} flux^{old}}{\sum_{i=1}^{\#\,nodes} flux^{old}} \times 100 < 0.0001$$

$$k\ error = \frac{k^{new} - k^{old}}{k^{old}} \times 100 < 0.0001$$

   Numerical Set up: - use 10 grids i.e. set delta x = 12
   - use an initial flux of 1.0 in all grids
   - use an initial guess of k=0.7

   HINT : you will have two iterative loops, an “inner” loop which is the Gauss Siedel iteration for the flux, given a k value, and an “outer” loop which will update and converge on the value of k. Consider combining the two iterations.

   Normalize the solutions to have a maximum flux of 1.0. Please hand in a copy of your source code.

   b. Compare the effective k value calculated analytically and numerically. Compare the flux distributions calculated analytically and numerically.

3. Calculate the transient solution using the semi-implicit method. Plot the center line flux and k as a function of time. Compare this to a plot of the center line flux as a function of iterations for Question 2. For this transient solution, devise a “controller” to adjust k so that a steady state is reached.