Homework 16

Web Problem #6

1. Now that you have seen the neutron diffusion equation for mono-energetic neutrons, you are ready to investigate the neutron diffusion equation for multiple “energy” groups. Just as with reaction calculations, we can break the flux into pieces, each one representing the neutrons in a specific energy region. However, the neutrons in one group can exit and enter other energy groups, which means the flux equations are tightly coupled. For this assignment, you will derive a 4-group diffusion theory for neutrons in a bare, homogenous, spherical reactor. This reactor is at steady state, but is not necessarily critical. The following assumptions should be used in this derivation:
    a. Fission neutrons are only born in the top two groups, i.e. groups 1 and 2.
    b. The fast neutron generation distribution is as follows: $X_1 = 0.75$, $X_2 = 0.25$.
    c. Thermal neutrons only exist in the bottom group, i.e. group 4.
    d. Only thermal neutrons induce fissions.
    e. There are no up-scatterings in the thermal group (i.e. neutrons only lose energy)
    f. The absorption and scattering cross sections can be combined to form a “removal” cross section, Σ_R.
    g. Scattered neutrons will only drop to adjacent energy levels. This means that the scattering cross section for group 1 represents neutrons scattered to group 2 only, or $\Sigma_{s1,2}$, etc.
    h. Because cross sections are energy dependent, there is a separate cross section of each type for each energy group, indicated by the appropriate subscript.
    i. ν is specific to each energy group… however, only one energy group undergoes fission…

2. Using the equations from problem 1, set up the coupled-equation matrices for solving these ODEs. Do not actually attempt to solve the equations (more data is needed), but find cross section data from the IAEA Database, and insert them into the equations from problem 1, then form matrices with these values which can be used to develop a solution for the flux fraction in each group for a ***critical*** reactor composed of pure ^{239}Pu.