NE 583 Radiation Transport Methods

Test#2

Due by Midnight Nov. 18, 2019

Please work the following problems **independently**. (This means get no help from anyone but the instructor.) E-mail the results to me by the deadline.

1. Find the microscopic absorption cross section for U238 for an energy group that spans from 6 eV to 7 eV for the following mixtures:
   a. 100% U238
   b. 50/50 split (by atom) of H and U238
   c. infinitely dilute U238 in hydrogen

   Assumptions:
   a. Flux spectrum can be approximated by $1/E\sigma_t$, where σ_t denotes the macroscopic total cross section.
   b. Hydrogen has a total cross section of 20 barns (all scattering).
   c. U238 has a scattering cross section of 5 barns and an absorption resonance approximated by the "chapeau" equation:

$$\tilde{\sigma}_a(E) = \begin{cases} 0 \text{ for } E < 6.62 \text{ or } E > 6.72 \\ 140000 \times (E - 6.62) \text{ for } 6.62 < E < 6.67 \\ 140000 \times (6.72 - E) \text{ for } 6.67 < E < 6.72 \end{cases}$$

2. For the group boundaries given in Problem #1, find the within-group microscopic elastic scattering cross section for hydrogen (A=1). Assume a 1/E flux spectrum. (Hint: It will NOT be 20 barns because not all of the scattered neutrons will stay in the group.)

3. For the following 3-group cross sections, find:
   a. The k-effective eigenvalue AND corresponding group fluxes.
   b. The B^2 eigenvalue AND the corresponding group fluxes.

   For consistency, please normalize the flux shape to one fission neutron produced. In part (b), approximate the diffusion coefficient, D, by $1/3\sigma_{transport}$.

   [Hint: These cross sections come from NE571 and represent a Sequoyah fuel pin at beginning of life. Therefore, k-infinity should be 1.2-1.4.]

	Groups		
	1	2	3
Total	0.326	0.685	2.500
Nu*Fission	0.0343	0.01316	0.2021
Transport	0.2074	0.380	1.627
Scat to group 1	0.227	0	0
Scat to group 2	0.085	0.653	0
Scat to group 3	0	0.014	2.372
Chi	0.735	0.265	0

4. From the results of Problem #3a:
   a. Collapse the cross sections to one group.
   b. Show that the k-effective eigenvalue has not changed.
   c. There are two ways to get the one group diffusion coefficient: Flux-weight the transport cross sections and use the resulting value in $1/3\sigma_{transport}$ OR flux weight the 3-group diffusion coefficients themselves. Which way gives the more accurate one-group B^2 eigenvalue?

5. Find the weights and mu values for an S_{16} 1D quadrature.

6. Define the S_{10} level symmetric 3D quadrature by giving the direction cosines and weights for the first octant. Find the optimum μ_1.