22.05 Exam 3 - Fall 2008
50 minutes

1.
    a. Write down the multigroup diffusion equations using 3 energy groups. Only assume that there are no external sources.
    b. Rewrite these equations assuming that 1) all fission neutrons are born into the fast group and 2) no upscattering occurs.
    c. Now assume that the leakage terms in group 2 and 3 are much less than their respective collision terms. Determine the corresponding modified one group diffusion equation.
    d. Using the modified one group diffusion equation, determine the critical dimensions of a bare cube reactor using the information provided below. Ignore the extrapolation distance for this problem.

$\nu\Sigma_{f,1} = .01 \text{ cm}^{-1}$ $\Sigma_{s,1\to2} = .25 \text{ cm}^{-1}$

$\Sigma_{s,1\to3} = .15 \text{ cm}^{-1}$ $\Sigma_{R,1} = .1 \text{ cm}^{-1}$

$\nu\Sigma_{f,2} = .125 \text{ cm}^{-1}$ $\Sigma_{s,2\to3} = .15 \text{ cm}^{-1}$

$\Sigma_{R,2} = .5 \text{ cm}^{-1}$

$\nu\Sigma_{f,3} = .5 \text{ cm}^{-1}$ $\Sigma_{a,3} = 1 \text{ cm}^{-1}$

$M^2 = 27 \text{ cm}^2$

2.   A 1-D slab reactor of total thickness A is surrounded by a reflector of thickness B (the reflector thickness on either side of the reactor is B). Assume that the reactor and reflector have different properties.
    a. Write down the correct diffusion equations for each regions and their corresponding general solutions.
    b. State all the boundary conditions you would use to solve for the coefficients of the general solutions.
    c. Use these boundary conditions to solve for the flux shapes in the reactor and reflector.
    d. Sketch the flux distribution throughout the reactor and reflector.
    e. If the reactor is initially critical, how will the flux distribution within the reactor and reflector change when boron is inserted into the reactor? Sketch this difference on the same plot as the previous sketch. How will the power change over time?

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