22.39 HW#3

Fall 2005 Problem Statement

1. Using two-group diffusion theory, calculate the critical mass of ^{235}U in a bare, spherical, thermal, homogeneous reactor consisting of ^{235}U and graphite with

$$\frac{N_M}{N_F} = 2\text{x}10^3 \qquad \text{and} \qquad L_1^2 = 0.037 \quad m^2$$

where N_M and N_F are the atom densities of the moderator and the fuel, respectively, and L_1 is the slowing down diffusion length of graphite. Assume that the fast fission factor and the resonance escape probability are each equal to unity.

2. The *reactor period* T is defined as the time required for the power to change by a factor of e, i.e., $P(t) = P_0\exp(t/T)$. The presence of delayed neutrons slows down the rate of decrease of reactor power when a large negative reactivity is inserted. Why is it claimed that T approaches -80 seconds in such a case?

3. After operating at a thermal flux of 10^{18} neutrons/$m^2\cdot s$ for a long time, a reactor is shut down. How long will it take the xenon concentration to rise to a maximum? What is the value of xenon poisoning at that time?