NUCL 510 Nuclear Reactor Theory I
Fall 2011

Homework #5

Due September 29

1. The differential scattering cross section is generally represented by a Legendre polynomial of the cosine of the scattering angle in the center-of-mass system (μ_c) as

   $$\sigma_s(E,\mu_c) = \frac{\sigma_s(E)}{2\pi}\sum_{n=0}^{N}\frac{2n+1}{2} f_n(E)P_n(\mu_c) \,.$$

   For the elastic scattering and discrete inelastic scattering, the energy transfer and the deflection angle are completely correlated, and thus the differential scattering cross section can be written as a function of the scattered neutron energy as

   $$\sigma_s(E \to E') = 2\pi\sigma_s(E,\mu_c)\left|\frac{d\mu_c}{dE'}\right| = \frac{\sigma_s(E)}{(1-\alpha)E}\sum_{n=0}^{N}(2n+1) f_n(E)P_n\left[\mu_c(E,E')\right]$$

   Using the data given below for incident neutron energy of 600 keV, determine and plot the energy distribution of the scattered neutrons.

	H-1	Na-23	U-238
f_0	1.00000E+00	1.00000E+00	1.00000E+00
f_1	-1.38363E-03	2.50710E-01	1.08577E-01
f_2		1.36480E-01	9.09901E-03
f_3		-3.77540E-03	4.24348E-04
f_4			1.13003E-05

2. The scattering kernel is commonly represented by a Legendre polynomial expansion in the form

   $$\sigma_s(E' \to E,\mu_s) = \sum_{l=0}^{L}\frac{2l+1}{4\pi}\sigma_s^l(E' \to E)P_l(\mu_s)$$

   where μ_s is the cosine of the scattering angle in the laboratory system, and the Legendre expansion coefficient of the scattering transfer cross section can be written as

   $$\sigma_s^l(E \to E') = 2\pi\int_{-1}^{1} d\mu_s\sigma_s(E \to E',\mu_s)P_l(\mu_s) = \sigma_s(E \to E')P_l[\mu_s(E,E')]$$

   $$= \frac{\sigma_s(E)P_l[\mu_s(E,E')]}{(1-\alpha)E}\sum_{n=0}^{N}(2n+1) f_n(E)P_n[\mu_c(E,E')]$$

   Using the data in Problem 1, determine and plot the Legendre expansion order up to $L = 5$.