Nuclear Engineering 150: Midterm 2 Study Guide

Disclaimer: This is not an official study guide. Stuff ~~might~~ **is** wrong. Use the lecture notes and book!

Note: Everything in this guide is from the text () or lecture, or office hours and should be cited as completely as possible.

Contents

1 Neutron Slowing Down

1.1 Lethargy

- Lethargy (u) is a measure of the amount that a neutron has slowed down *relative* to an energy E_0. It is important to note that this is a relative measure, it only tells us about the neutron's energy when compared to our reference value.[1, Lec. 9]

$$u = \ln\left(\frac{E_0}{E}\right) = \ln(E_0) - \ln(E)$$

- As the neutron slows down, relative to E_0, the value of lethargy goes *up*. This is why we call it a measure of the slowing down. This is why we call it lethargy because it's like a measure of the neutron's sleepiness or something; some nuclear engineer obviously thought he was being super cute.[1, Lec. 9]

- Every collision causes a decrease in neutron energy (and increase in neutron lethargy). If the neutron goes from E_i to E_f after a scattering event, we can solve for the difference in the initial and final energies.

$$\Delta u = \ln\left(\frac{E_0}{E_f}\right) - \ln\left(\frac{E_0}{E_i}\right) = \ln\left(\frac{E_i}{E_f}\right)$$

  This is also called the logarithmic energy loss.[1, Lec.9]

- If we want to know the average logarithmic energy loss per collision, we can take the average. We call that squiggle (written ξ). We will use the energy loss per collision from the last midterm, and denote the original energy E and the final energy E':

$$\xi = \overline{\ln\left(\frac{E}{E'}\right)} = \int_{\alpha E}^{E} dE' \ln\left(\frac{E}{E'}\right) p(E \to E')p = \int_{\alpha E}^{E} dE' \ln\left(\frac{E}{E'}\right) \frac{1}{(1-\alpha)E}$$

  Finally, you get:

$$\xi = 1 + \frac{\alpha}{1-\alpha}\ln(\alpha)$$

  Note that this doesn't depend on the original energy E. This makes sense, because it's just an average value, we integrated over all the possible energies. In the end, it's just a function of what it's colliding with, because:

$$\alpha = \left(\frac{A-1}{A+1}\right)^2$$

  [1, Lec. 9]

References

[1] Jasmine Vujic. Nuclear engineering class lectures. Spring 2015.