Problem Set 02

[15] 1. O & N: Chapter 3: Homework Problems: 1
Find $\bar{v}$ and the generation time Λ for thermal neutrons. Calculate $\bar{v}$ as the spectrum average for a normalized Maxwell spectrum:

$$\phi(E)dE = \frac{E}{kT} e^{-\frac{E}{kT}} \frac{dE}{kT}$$

Use T = 900 K and $\nu\Sigma_f = 0.3/\text{cm}$.

2. O & N: Chapter 3: Homework Problems: 2
Find $\bar{v}$ and $\overline{\left(\frac{1}{v}\right)}$ for a two group representation of a thermal reactor spectrum, composed for simplicity of a Maxwellian and a $\frac{1}{E}$ spectrum:

$$\begin{aligned} \phi_1(E) &= \frac{a}{E} && , \ for\ 0.2\ \mathbf{eV} \leq E \leq 2\ \mathbf{MeV} \\ \phi_2(E) &= \frac{b\,E}{(k\,T)^2}\, e^{-\frac{E}{kT}} && , \ for\ 0 \leq E \leq \infty \end{aligned}$$

[5] (a) Find a and b such that the two components of the normalized $\phi(E)$ provide equal contributions to the energy integral.

[4] (b) Find the average velocities for both groups ($\bar{v}_1$ and $\bar{v}_2$). If necessary, leave as a function of temperature, T, in [K].

[4] (c) Express the two group definitions of $\bar{v}$ and $\overline{\left(\frac{1}{v}\right)}$ as functions of temperature, T, in [K].

[2] (d) Find the corresponding numerical values for T = 900 [K].

[5] 3. O & N: Chapter 3: Review Questions: 6
Give two equivalent differential equations for the power of a nuclear reactor. Have one equation use k & l and the other use ρ & Λ. Treat **all** neutrons as prompt and neglect external sources.

4. Using the answer from Question 3 that contains ρ & Λ, account for the presence of a constant external source of neutrons in the reactor by introducing S_o, expressed in [J], into the differential equation.

[1] (a) What is the differential equation describing this new system? Be sure to provide the initial condition.

[5] (b) Solve the differential equation for a constant ρ, such that $k \neq 1$.

[5] (c) Solve the differential equation for k = 1.

[2] (d) What is the value of k that renders a steady state solution for a source S_o?

[1] (e) What is the steady state multiplication factor, M, for the reactor in terms of k?
Note: $\mathrm{M} = \dfrac{P_o}{S_o}$

[1] (f) Plot $\dfrac{M}{l}$ vs. k.