NPRE412 Spring 2025
HW 9 Due 2025.04.01

- Show your work.
- This work must be submitted online as a `.pdf` through Canvas.
- Work completed with LaTeX or Jupyter earns 1 extra point. Submit source file (e.g. `.tex` or `.ipynb`) along with the `.pdf` file.
- If this work is completed with the aid of a numerical program (such as Python, Wolfram Alpha, or MATLAB) all scripts and data must be submitted in addition to the `.pdf`.
- If you work with anyone else, document what you worked on together.

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1. (50 points) What is the value of uranium utilization in LWRs, for a once-through fuel cycle, if the fuel acheives a burnup of 45000 MWd/tU? Assume enrichment of fuel is 3.2% and tails are equal to 0.28% (Tsoulfanidis, 7.1).

Solution: The uranium utilization for LWRs is 0.815% for the given specifications.

To solve, first calculate the feed factor:

$$FF = \frac{x_p - x_w}{x_f - x_w} \tag{1}$$

Then, calculate the mass ratio of uranium after the cycle finishes to when you load the cycle as a function of burnup.

$$m_r = BU \cdot 1.23\frac{g}{MWd} \cdot 1e-6\frac{ton}{gram} = \frac{M_f}{M_l} \tag{2}$$

Finally, calculate the utilization using Eq. 7.2:

$$u_{lwr} = \frac{m_r}{FF} = 0.815\% \tag{3}$$

2. (50 points) Repeat the previous problem for a breeder reactor. Assume $\gamma = 0.02$ (Tsoulfanidis, 7.2).

Solution: For a breeder reactor with the given specifications, the utilization is 74.55%.

Using Eq. 7.3:

$$u_{breeder} = \frac{m_r}{m_r(1-\gamma)+\gamma} = 74.55\% \tag{4}$$