Homework 06 (12Dec23)

Name: `your name`

Guidance:

- Upload your answers in the Blackboard submission portal as:

  lastname-firstname-homework-xx.pdf or **lastname-firstname-homework-xx.ipynb**

Table of Problems

Problem 1 (20 pts)

What is the minimum number of elastic scattering collisions required to slow a neutron down from 1 MeV to 1 eV in the materials below.

1.1)(5 pts) Hydrogen.

Answer:

1.2)(5 pts) Deuterium.

Answer:

1.3)(5 pts) ^{12}C.

Answer:

1.4)(5 pts) ^{238}U.

Answer:

Problem 2 (20 pts)

In contrast to Problem 1, assuming that any elastic collision in Problem 1 loses the average value, ξ, repeat the calculation of the number of elastic collisions for the same materials and compare with the results in Problem 1.

2.1)(5 pts) Hydrogen.

Answer:

2.2)(5 pts) Deuterium.

Answer:

2.3)(5 pts) ^{12}C.

Answer:

2.4)(5 pts) ^{238}U.

Answer:

Problem 3 (10 pts)

Why all working nuclear reactors either use the thermal or fast neutron spectrum? What is the issue in between these spectra?

Answer:

Problem 4 (10 pts)

What are the desired properties of a neutron moderator material? List three quantities used to assess the effectiveness of a moderator material and define these quantities mathematically.

Answer:

Problem 5 (20 pts)

Neutrons scatter elastically at 1 MeV. After one scattering collision, calculate the fraction of the neutrons that will have energies of less than 0.5 MeV when they scatter from the following materials:

5.1)(5 pts) Hydrogen.

Answer:

5.2)(5 pts) Deuterium.

Answer:

5.3)(5 pts) ^{12}C.

Answer:

5.4)(5 pts) ^{238}U.

Answer:

Problem 6 (20 pts)

Solve, computationaly, the point reactor model with reactivity step change using the course Jupyter notebook 01 (01-cte-rho-pt-reactor.ipynb) described in class with delayed neutrons for ^{235}U as follows:

6.1)(5 pts) Using 9 cents reactivity step, report the gain in power (neutron density) after 0.1 s. Show a plot for the neutron density and precursors concentration from 0 to 0.1 s.

Answer:

6.2)(5 pts) Show a plot for 6.1) from 0 to 20 s. Explain the shape of the curve for neutron density and precursors concentration.

Answer:

6.3)(10 pts) An operator needs to step up the power of the reactor 1000 fold (say from 1 W to 1 kW) in 2 hours. Estimate the reactor period, T, needed? Estimate the step reactivity, $\widetilde{\rho/\beta}$, in cents needed? Run the computational model with your estimates and compute the error in the power after 2 hours (show the plot of the run). Run the computational model with better choices of ρ/β until the correct power uprate (1 kW) is obtained, then compare ρ/β against the original estimate; what is the error in $\widetilde{\rho/\beta}$?

Answer: