

Homework 03 (23Oct24)

Name: your name

Guidance:

- Upload your answers in the Blackboard submission portal as:
lastname-firstname-homework-xx.pdf or lastname-firstname-homework-xx.ipynb

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Problem 1 (25 pts)

Cross sections of ^{235}U at 1 MeV are as follows: $\sigma_a = 2.1$ b, $\sigma_{\text{in}} = 1.8$ b, $\sigma_f = 1.2$ b, and $\sigma_e = 3.3$ b. Other cross sections can be considered negligible. Compute at this energy:

1.1)(10 pts) The total cross section.

Answer:

1.2)(10 pts) The capture-to-fission cross section ratio.

Answer:

1.3)(5 pts) Comment on this ratio in relation to fast neutron fission reactors.

Answer:

Problem 2 (25 pts)

The fission product ^{131}I has a half-life of 8.03 days and it is produced in fission with a yield of 2.9%, that is, 0.029 atoms of ^{131}I are produced per fission. Calculate the steady-state activity of this radionuclide in a reactor operating at 3.3 GW.

Answer:

Problem 3 (50 pts)

An extremely thin foil (say $< 1 \mu\text{m}$) of pure ^{235}U is exposed to a constant neutron flux of 10^{14} neutrons/cm²-s. Interaction data: $\sigma_a = 684$ b, $\sigma_f = 585$ b. Pertinent questions follow.

3.1)(10 pts) Write down the major nuclear reactions taking place in the foil.

Answer:

3.2)(10 pts) Does the mass of the foil change with time? Explain whether it decreases, increases, or stays the same, and why.

Answer:

3.3)(10 pts) If the mass of the foil changes with time, derive a formula of its variation with time relative to its initial value. Explain the assumptions in your model.

Answer:

3.4)(10 pts) Using the derived formula, what is the value of the mass of the foil, relative to its initial value, after a very long time ($t \rightarrow \infty$) of exposure to the constant neutron flux?

Answer:

3.5)(10 pts) Using the derived formula, how long does it take for a relative variation of mass of 1% to occur, if any?

Answer: