Homework 03 (14Oct23)

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 (10 pts)

A gamma photon travels in empty space without losing energy.

1.1)(5 pts) If you could stop the gamma photon, what would the "rest mass" be?

Answer:

1.2)(5 pts) What is the "mass" of the photon in motion as a function of frequency?

Answer:

Problem 2 (15 pts)

Crosss sections of ^{235}U at 1 MeV are as follows: σ_a = 2.1 b, σ_{in} = 1.8 b, σ_f = 1.2 b, and σ_e = 3.3 b. Other cross sections can be considered negligible. Compute at this energy:

2.1)(5 pts) The total cross section.

Answer:

2.2)(5 pts) The capture-to-fission cross section ratio.

Answer:

2.3)(5 pts) Comment on this ratio in relation to fast neutron fission reactors.

Answer:

Problem 3 (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 equilibrium activity of this radionuclide in a reactor operating at 3.3 GW. Note: the charge of the electron is 1.60219 10^{-19} C.

Answer:

Problem 4 (50 pts)

An extremely thin foil (say < 1 μm) of pure ^{235}U is exposed to a constant neutron flux of 10^{14} neutrons/cm^2-s. Interaction data: $\sigma_a = 684$ b, $\sigma_f = 585$ b. Pertinent questions follow.

4.1)(10 pts) Write down the major nuclear reactions taking place in the foil.

Answer:

4.2)(10 pts) Does the mass of the foil change with time? Explain whether it decreases, increases, or stays the same, and why.

Answer:

4.3)(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:

4.4)(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 ($t \to \infty$) of exposure to the constant neutron flux?

Answer:

4.5)(10 pts) Using the derived formula, how long does it take for a relative variation of masss of 1% to occur, if any?

Answer: