Engy-4340: Nuclear Reactor Theory Fall 2023 UMass Lowell; Prof. V. F. de Almeida **06Sep23**

Homework 01 (11Sep23)

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)

Calculate the atom density of U-235 in uranium enriched to 15% (a/o) in this isotope if the physical density of uranium is 19 g/cm^3?

Answer:

Problem 2 (20 pts)

What mass of Co-60, $t_{1/2} = 5.26$ y, will have the same number of curies as 10 g of Sr-90, $t_{1/2} = 28.8$ y?

Answer:

Problem 3 (20 pts)

Suppose Co-60 and Sr-90 have the same activity at some point in time. Next, they are allowed to decay for 10 years. It is found that after 10 years 1.0 Ci of Co-60 remains. How many curies of Sr-90 remain?

Answer:

Problem 4 (20 pts)

Po-210 decays to Pb-206 by emitting an alpha particle, $t_{1/2} = 138$ d, $E = 5.305$ MeV.

4.1)(6 pts) How many curies are there in 1 g of pure Po-210?

Answer:

4.2)(6 pts) How many watts of heat are produced by 1 g of Po-210?

Answer:

4.3)(8 pts) What mass of Pb-210 is required to produce 1 MW of thermal energy from its radioactive decay?

Answer:

Problem 5 (20 pts)

Consider the fission product chain $A \xrightarrow{\beta} B \xrightarrow{\beta} C$ with decay constants λ_A and λ_B for A and B respectively. A reactor is started up at $t = 0$ and produces fission product A at a constant rate A_0 thereafter. Assuming that B and C are not produced directly from fission and are not initially present in the reactor:

5.1)(6 pts) Find $n_A(t)$ and $n_B(t)$.

Answer:

5.2)(6 pts) What are $n_A(\infty)$ and $n_B(\infty)$?

Answer:

5.3)(8 pts) Find the maximum of $n_B(t)$.

Answer: