Homework 06 (19Dec24)

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 (100 pts)

The single-point reactor kinetic equation for neutron balance covered in class not including delayed neutrons was:

$$\frac{dn}{dt} = -\Gamma\,\Sigma_a\,v\,n + \dot{S}(t) + \nu_{\mathbf{p}}\Sigma_{\mathbf{f}}\,v\,n - \Sigma_a\,v\,n.$$

1.1)(25 pts) State the assmuptions that led to this equation and identify each one of the terms including the variables and their units. Be comprehensive.

Answer:

1.2)(25 pts) As done in class, introduce delayed neutrons in the above equation and arrive at the equations

$$\frac{dn}{dt} = \dot{S}(t) + \frac{\big((1-\beta)k - 1\big)}{\ell}n + \sum_{i=1}^{6}\lambda_i\,c_i,$$
$$\frac{dc_i}{dt} = \beta_i\frac{k}{\ell}\,n - \lambda_i\,c_i \qquad i = 1\ldots,6,$$

demonstrating the steps taken using the definition of k and ℓ given in class.

Answer:

1.3)(25 pts) Provide a description of each term in these equations as they relate to the original balance equations they originated from.

Answer:

1.4)(25 pts) Defining the reactivity $\rho = \frac{k}{k-1}$ and the neutron generation time $\Lambda = \frac{\ell}{k}$ show that the reactivity form of the equations above is

$$\frac{dn}{dt} = \dot{S}(t) + \frac{\rho - \beta}{\Lambda}n + \sum_{i=1}^{6}\lambda_i\,c_i,$$
$$\frac{dc_i}{dt} = \frac{\beta_i}{\Lambda}\,n - \lambda_i\,c_i \qquad i = 1\ldots,6,$$

and comment on the revealing fact of the effect of delayed neutrons in controlling a reactor. What value of ρ is dangerous?

Answer: