Modeling and control of a nuclear power plant

1. Modelling

The derivative y' of the neutron flux in a nuclear reactor is proportional (k = 1) to the neutron flux already created substracted by the one absorbed by the carbon bars that are supposed to be equal to a control signal x.

1. Write the differential equation of the evolution of the neutron flux in the reactor.
2. Simulate this differential equation by assuming an initial neutron flux equal to 1 and no absorption. Observe the curve. What does it say about the nature of the phenomenon?
3. Write the transfer function producing y as a function of x. What does it tell us about nature of phenomenon? (that is, stability)

2. Control of this plant

Open loop control

1. What constant absorption must be made to prevent the neutron flux from exploding?

Closed loop control

We proposed to control the system in closed loop with a PID of the type
(as + b) / (cs + d)

1. Calculate the parameters a, b, c, d so that:
(a) the poles of the closed-loop system are '

$$2e^{(3i\pi/4)} \quad \text{and} \quad 2e^{(5i\pi/4)}$$

(b) the gain of the closed-loop system is 1

2. Simulate the closed-loop system to keep the neutron flux constant equal to 1. What do we see?
3. Enter a step function makeing the neutron flux jump from 1 to 2. Observe the resulting curves