1. **Modelling**

The derivative $y'$ of the neutron flux in a nuclear reactor is proportional ($k = 1$) to the neutron flux already created subtracted 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 $2e^{(3iπ/4)}$ and $2e^{(5iπ/4)}$
   (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 making the neutron flux jump from 1 to 2. Observe the resulting curves