

**Nuclear Engineering 150 – Discussion Section**  
**Team Exercises #3**

## Problem 1

A reactor is operating for a long time at some known power density  $P_0$ . Then, it instantaneously changes power to some power density  $P_1$ . One fission product of interest is  $^{135}\text{Xe}$ , though it has a negligible yield from the initial fission reaction.  $^{135}\text{Xe}$  precursors  $^{135}\text{Te}$  and  $^{135}\text{I}$  are produced with a combined yield,  $y$ , of approximately 6%, before decaying via  $\beta^-$  decay to  $^{135}\text{I}$  and  $^{135}\text{Xe}$  respectively. Find the number density of  $^{135}\text{Xe}$  as a function of time after the power change. (For convenience, let  $Q_f$  be the energy produced in a fission reaction, and let  $\phi$  be the flux in the reactor. Your answer may be left in terms of these variables.)

Nucleus	Half-life	Thermal $\sigma_a$
$^{135}\text{Te}$	19.0 s	$\sim 0$
$^{135}\text{I}$	6.6 hr	$\sim 0$
$^{135}\text{Xe}$	9.2 hr	$2.6 \times 10^6$ barns

## Problem 2

- a) Find the excitation energy in  $^{236}\text{U}$  when a neutron with zero kinetic energy is absorbed by  $^{235}\text{U}$ .
- b) Find the excitation energy in  $^{239}\text{U}$  when a neutron with zero kinetic energy is absorbed by  $^{238}\text{U}$ .
- c) The activation energy for  $^{236}\text{U}$  is 6.2 MeV and the activation energy for  $^{239}\text{U}$  is 6.6 MeV. Will fission occur in each of these cases? Identify  $^{235}\text{U}$  and  $^{238}\text{U}$  as fissile or fissionable and explain.
- d) A  $^{238}\text{U}$  nuclei absorbs a 2 MeV neutron and fissions into  $^{132}\text{Sn}$ ,  $^{106}\text{Mo}$ , and a neutron. If the neutron is produced with 2.5% of the total energy released in the reaction, does it have enough energy to fission another  $^{238}\text{U}$  atom?

Nucleus	Mass
$n$	1.00866492 amu
$^{106}\text{Mo}$	105.918137 amu
$^{132}\text{Sn}$	131.917816 amu
$^{235}\text{U}$	235.043930 amu
$^{236}\text{U}$	236.045568 amu
$^{238}\text{U}$	238.050788 amu
$^{239}\text{U}$	239.054293 amu