

**Nuclear Engineering 150 – Discussion Section**  
**Team Exercises #4**

## Problem 1

A reactor contains 5% (by atom) enriched uranium dioxide, which is 15% of the entire core by volume.

- a) Calculate the macroscopic cross section for this core if we were to treat it as a homogeneous volume.
- b) If the reactor were a cube with a side length of 4 m and a beam of  $10^{15}$  thermal neutrons were incident on one face of the cube, how many neutrons would we expect to make it through to the other side?

| Nucleus              | Thermal $\sigma_t$ (b)              | Mass (g/mol) |
|----------------------|-------------------------------------|--------------|
| $^1\text{H}$         | 20.8                                | 1.008        |
| $^{16}\text{O}$      | 3.5                                 | 15.995       |
| $^{235}\text{U}$     | 607.5                               | 235.044      |
| $^{238}\text{U}$     | 11.8                                | 238.050      |
| Compound             | $\rho \left( \text{g/cm}^3 \right)$ |              |
| $\text{H}_2\text{O}$ | 1.0                                 |              |
| $\text{UO}_2$        | 10.4                                |              |

## Problem 2

A neutron beam with an intensity of  $2 \times 10^{12}$  neutrons/(cm<sup>2</sup>·s) is incident on an unknown shielding material and has a beam spot of 5 cm<sup>2</sup>. The shielding material has a thickness of 10 cm.

- a) On average,  $3.0 \times 10^9$  neutrons/s make it through the shield uncollided. What is the macroscopic cross section of the shield material?
- b) What is the mean free path of a neutron in the shielding material?
- c) If a single beam pulse is 10  $\mu$ s, how many collisions are expected to take place in the shielding material?