NENG 685 Fall 2017
HW 3 Due Nov. 1, 2017

Name:

On homework:

- If you work with anyone else, document what you worked on together.
- Show your work.
- Always clearly label plots (axis labels, a title, and a legend if applicable).
- Homework should be done "by hand" (i.e. not with a numerical program such as MATLAB, Python, or Wolfram Alpha) unless otherwise specified. You may use a numerical program to check your work.
- If you use a numerical program to solve a problem, submit the associated code, input, and output (email submission is fine).

Do not write in the table to the right.

Problem	Points	Score
1	10	
2	10	
3	10	
4	5	
5	5	
6	10	
Total:	50	

1. (10 points) Determine the macroscopic scattering cross section of UO_2 as a function of a generic enrichment factor $\gamma = N_{U-235}/N_{U-238}$ where N is the atom density. Find its value assuming a density of $10\,\mathrm{g/cm^3}$, $\sigma_s^U \backsimeq 8.9\,\mathrm{b}$ and $\sigma_s^O \backsimeq 3.75\,\mathrm{b}$, and 5% weight enrichment.

2. (10 points) Briefly describe what each term in the Transport Equation [Eqn. (2)] physically represents.

$$\underbrace{[\hat{\Omega}\cdot\nabla\psi(\vec{r},\hat{\Omega},E)}_{A} + \underbrace{\Sigma(\vec{r},E)\psi(\vec{r},\hat{\Omega},E)}_{B} = \underbrace{\int_0^\infty dE' \int_{4\pi} d\hat{\Omega}'\,\Sigma_s(\vec{r},E'\to E,\hat{\Omega}'\cdot\hat{\Omega})\psi(\vec{r},\hat{\Omega}',E')}_{C}$$
$$+ \underbrace{\frac{\chi(E)}{k}\int_0^\infty dE'\,\nu\Sigma_f(\vec{r},E')\int_{4\pi} d\hat{\Omega}'\,\psi(\vec{r},\hat{\Omega}',E')}_{D} \qquad (2)$$

3. (10 points) List three assumptions *needed* to get from the Transport Equation to the Diffusion Equation.

4. (5 points) List four locations where the Diffusion Equation is not valid because the underlying assumptions do not hold; for each explain why the assumptions do not hold

in that location.

5. (a) (2 points) Write the **steady state**, 2D diffusion equation and explain how we typically characterize it from the viewpoint of labeling second order linear PDEs. Assume D is not a function of x or y for this part.

   (b) (3 points) Can you think of any physical cases in which this characterization would change?

6. (10 points) At what energy is the lowest isolated resonance of ^{235}U, ^{238}U, ^{239}Pu, and ^{240}Pu? Why do we care about that?