NE 155/255 Fall 2019
Homework #5 Due December 6th, 2019

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) 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).

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1. (30 points) (a) (10 points) Consider the PDF:

$$p(x) = 3x^2 + x$$

on the interval $0 < x < a$. What value of a will make $p(x)$ a valid PDF?

(b) (10 points) Consider the bounding function:

$$g(x) = 5\sqrt{x}.$$

What is the efficiency of rejection sampling using this bounding function for the above PDF? Use limits of $0 < x < a$, where a is the value calculated above.

(c) (10 points) When would we use rejection sampling? Give an example of a PDF and corresponding CDF that would require the use of rejection sampling.

2. (30 points) (a) (15 points) When using analog Monte Carlo methods, how can we improve the accuracy of our answers? How can we improve the precision? For the latter, include mathematical reasoning (equations) in your response.

(b) (15 points) What is the purpose of using variance reduction in Monte Carlo calculations? What precautions should be taken when using variance reduction methods?

3. (40 points) Write a Monte Carlo code to track particles and tally behavior of interest. Use the following parameters:

- 1-D space, from $x = 0$cm to $x = 10$cm
- Particles born uniformly randomly anywhere in region 1 (see below table)
- Isotropic scattering, either in the positive or negative direction
- Monoenergetic particles

- All particles are born with a weight of 1; this is not changed
- 100,000 histories

	Region 1	Region 2
Boundaries [cm]	[0,5)	[5,10]
$\Sigma_s[cm^{-1}]$	45	8
$\Sigma_\gamma[cm^{-1}]$	4	50

How many particles undergo capture reactions in region 2? How many forward scattering events occur in region 1? Values can be reported without error or variance here since the requested values are exact counts.