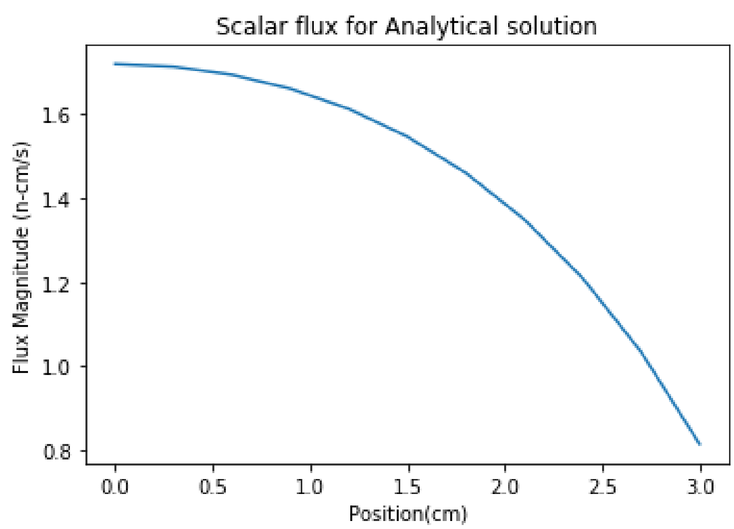
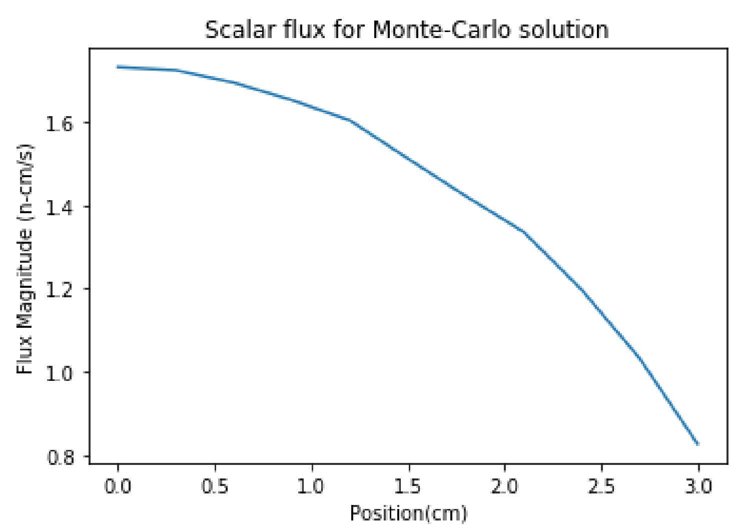
Project 3 Report

Problem 1

In this problem, the Monte Carlo method was used to solve a set of two-stream equations. The system consisted of a one dimensional space with the reflective left boundary at x=0 cm and the vacuum right boundary at x=3 cm and the values for total and scattering cross sections were known. This space was then divided into 10 cells with a uniform width of 0.3 cm. The MC code was run for 10000 batches with 1 particle per batch. The scalar flux was determined for each cell using the MC code.





The value for the half-range flux at the right boundary for the analytical solution had a magnitude of 0.8145 and the same value for the MC solution was 0.8274. The standard deviation for the batch-averaged cell fluxes and leakage at the right boundary and the standard deviation of the batch-averaged cell quantities relative to the analytical values are shown below.

Table 1. Standard Deviations for batch-averaged cell flux and leakage

Cell	std
1	0.001118
2	0.000891
3	0.000708
4	0.000587
5	0.000509
6	0.000453
7	0.000416
8	0.000372
9	0.000322
10	0.000258
leakage	0.0134

Table 2. Relative Standard Deviations for batch-averaged cell flux and leakage

Cell	std
1	0.0065
2	0.00052
3	0.000418
4	0.000353
5	0.000315
6	0.000293
7	0.000285
8	0.000275
9	0.000266
10	0.000249
leakage	0.01646

Compared to the analytical leakage value of 0.8145, the MC value was greater by 0.0129 which is within one standard deviation of the analytical value.

Problem 2

The second problem involved using monte carlo method to sample x and y values with P(x)=2x. This procedure was done for 10000 batches with 1250 samples for each batch. The values for E(x), E(x^2), and σ_x were analytically calculated from the p(x) and σ_{xbar} was calculated by dividing σ_x by the number of batches.

Table 3. Relevant Quantities for Problem 2

Quantity	Value
E(x)	0.66
E(x^2)	0.5
σ_x	0.2357
σ_{xbar}	0.00667

Further analysis showed that the proportion of x that fell within E(x) ± 1σ_{xbar} , E(x) ± 2σ_{xbar} , and E(x) ± 3σ_{xbar} were 0.6827, 0.9524, and 0.9976 respectively. This is very close to the proportion of x values that fall within 1σ_x , 2σ_x, and 3σ_x of the exact average which are 0.682, 0.954, and 0.997 respectively. That means that E(x) is very close to the true mean.

Problem 3

The same code from problem 2 was used but this time, the sampling of x was biased with p(^)(x)=1.

Table 4. Relevant Quantities for Problem 3

Quantity	Value
E(Wx)	0.66
E($(Wx)^2$)	0.8
σ_{Wx}	0.5962
σ_{Wxbar}	0.01685

Compared to σ_x , σ_{Wx} is larger so this biasing scheme is not a good one. The biased values were much less accurate than expected with the proportion of sampled Wx values falling within 1, 2, and 3 confidence intervals being 0, 0.0643, and 0.9354 respectively. The mean sampled value of Wx was 0.709 which is higher than the analytically determined value of 0.66. This could have been the result of errors in the code, however.