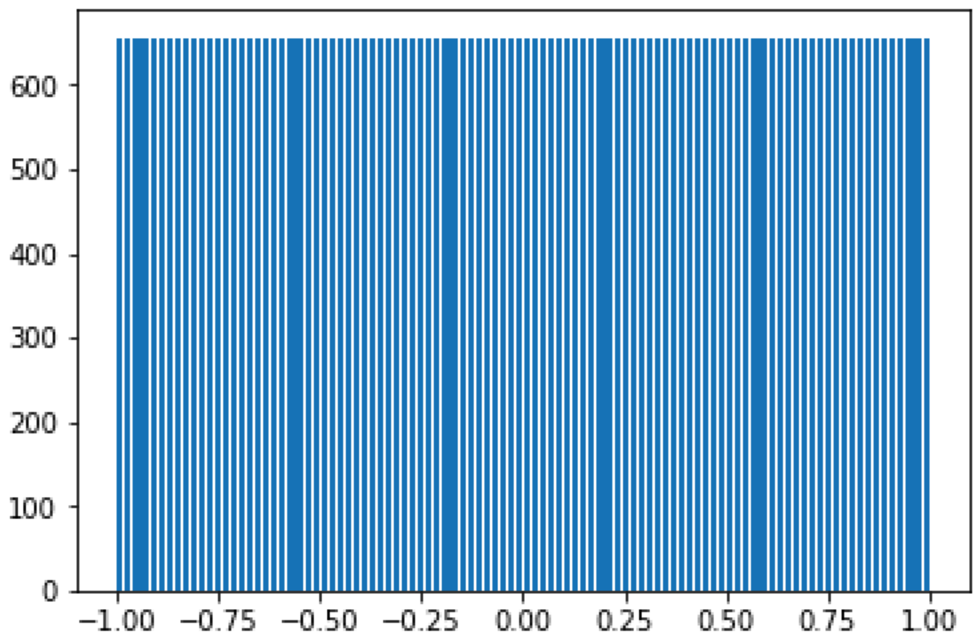
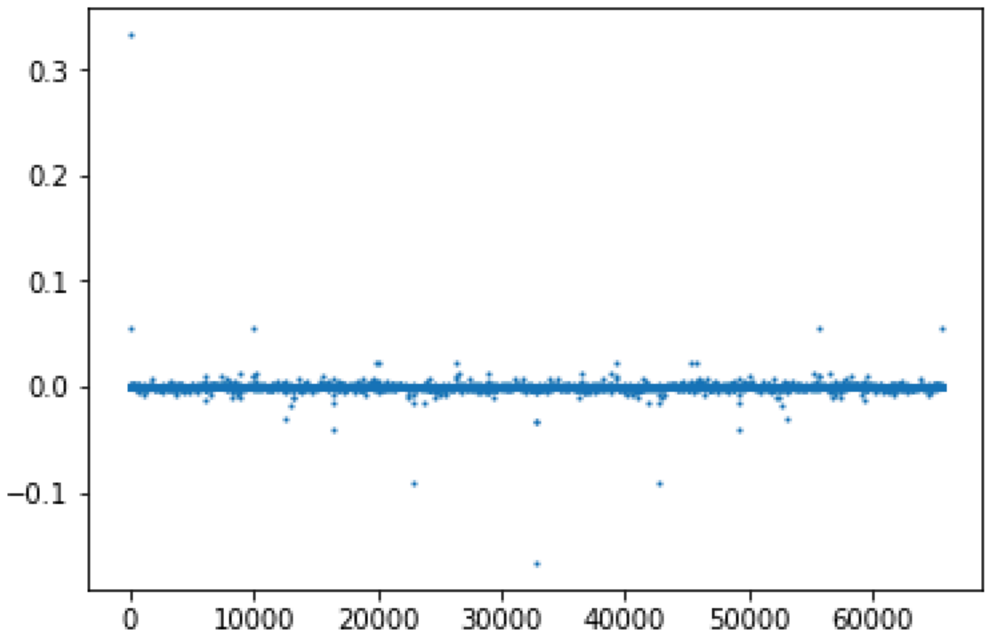
Question 1:
In this problem, I created a histogram of a hundred bins from the interval -1 to 1. This is showing a uniform distribution; all of the bins are the same height across the whole interval range. Here, the assignment said to pick an alpha, where alpha-1 is divisible by all prime factors of M and by 4 as well if M is divisible by 4. I chose alpha = 5 here. The assignment also said to choose a beta that is relatively prime, so I chose the Mersenne prime number of 2^{11}-1, which is 2047. Using the equation provided, I was able to create a list of random variables that were uniformly distributed. The results are shown in the graph below.



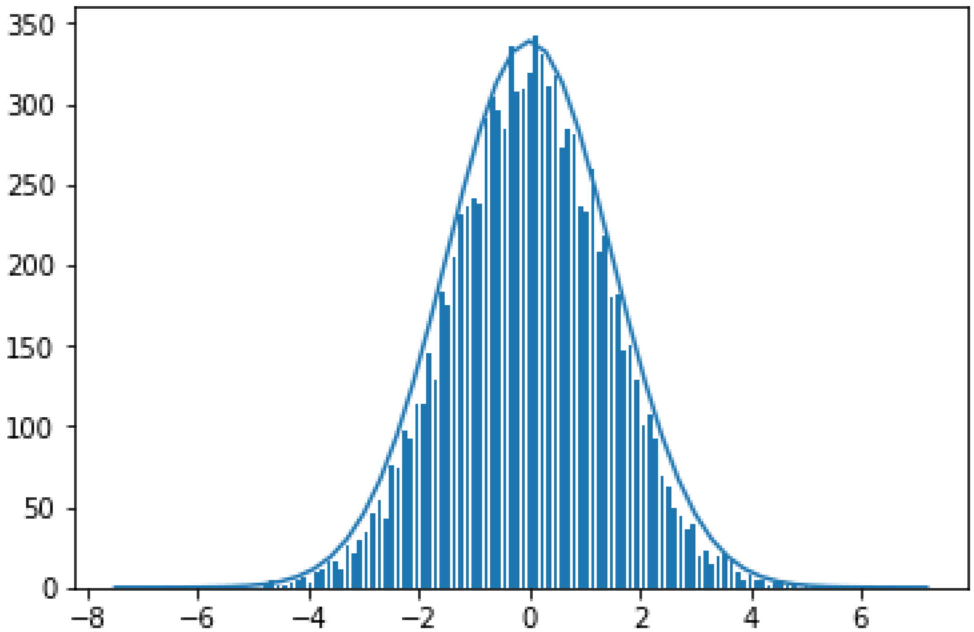
Question 2:
For this problem, we had to plot the auto-correlation function of the random sequence above. To do this, I used the values that were generated from the function created for the first problem and put them through the built in DFT in python. To do this, I first put the values through the DFT, then I took all those values and squared them. Then I took the absolute value because python had some weird number thing going on where not all the squared values were positive. After that, I took those values and divided them by M. Those were the final numbers that I took and plotted. To create the plot below, I used scatterplot method where those values are plotted as the y values and the x values are all the numbers from 0 to 2^{16}.
The graph of this can be seen below.



Question 3:

For this problem, we had to generate a few thousand random points and plot a bit counting histogram. We had to use 100 bins over the interval of -5 to 5 and compare this histogram to the function $e^{-x^2/2}$/sqrt(2pi).

For this problem, I randomly generated two lists, one of r's and one of theta's. To do this, I used the built in python random.uniform to generate these lists. I created them at a size of 5000 each. Then, I solved for the $2\sqrt{-\ln r} cos\theta$ and $2\sqrt{-\ln r} sin\theta$. I then appended both of these numbers to a list that was my list of random points. After this was done, I plotted the function $e^{-x^2/2}$/sqrt(2pi) over the graph. I had to change the scaling of this graph a bit to make it fit the shape of the histogram because the max height of the $e^{-x^2/2}$/sqrt(2pi) graph is around 0.4. You can see that the graph of $e^{-x^2/2}$/sqrt(2pi) fits really well with the histogram once it is scaled properly. This is shown below.



350
300
250
200
150
100
50
0
−8
−6
−4
−2
0
2
4
6