

Science 2 Assignment 2

Total Marks: 10x3 = 30
Deadline: 28th February

Q1) Generate random numbers using the formula **(10 marks)**:

$$I_{j+1} = (AI_j + C) \bmod M$$

where $A = 106$, $C = 1283$, $M = 6075$ and $I_1 = 1$

You can use this random number generator to get N random numbers (I_1, I_2, \dots, I_N)

- Plot I_j vs j for $N = 1000$ **(2 marks)**
- Plot I_{j+1} vs I_j for $N = 1000$. What can you deduce from the plot? **(3 marks)**
- Plot the expectation value $E(I_j)$ as a function of N . $N = [1, 10, 50, 100, 200, 300, \dots, 1800, 1900, 2000]$. **(5 marks)**

Q2) Perform integration using the Monte Carlo method for the function applicable to you. The function you need to use is your Roll Number % 5 + 1. Therefore if your Roll Number is 2021101110, take option 1. Similarly for 2021101113, take option 4. **(10 marks)**

- $x \sin x$ in the range $[-\pi, \pi]$
 - $x^2 \cos x$ in the range $[-\pi/2, \pi/2]$
 - $e^{\cos x}$ in the range $[-3, 3]$
 - $e^x \cos x$ in the range $[-\pi/2, \pi/2]$
 - $\cos x - \cos^2 x$ in the range $[-\pi/2, \pi/2]$
- Find the integration value using $N = 100000$. **(4 marks)**
 - Plot the integration value as a function of N in the range $[1, 100000]$ with a gap of 1000, i.e, $N = 1, 1000, 2000, \dots, 100000$. **(6 marks)**

Q3) You need to simulate 1D Random Walks with N timesteps with step size of 1 in each timestep. The person has equal probabilities of moving in either direction, i.e, at each step the person can move $-1/+1$. **(10 marks)**

- a) A drunk person starts out at initial position “a”. Plot the probability that the person returns back to the origin after N timesteps for different values of N in the range of 1 to 100. **(3 marks)**
- b) Now assume, two drunk people start out at initial positions “a” and “b” respectively and take their steps simultaneously. Plot the probability that they meet again after N timesteps for different values of N in the range of 1 to 100. **(4 marks)**
- a) Plot the mean displacement for a drunk person after N steps for different values of N in the range of 1 to 100. You can assume that the person starts out at the origin. **(3 marks)**

To compute probabilities (in subparts a and b) and mean (in subpart c) simulate the experiments appropriate number of times (atleast 10000).

$$a = -(\text{Roll Number} \% 5 + 1); \quad b = \text{Roll Number} \% 5 + 1$$

Therefore, if your Roll Number is 2021101132, then $a = -3$, $b = 3$.
