Assignment 1 (10 marks).

Submission deadline: January 12, 2025 before the class starts.

Q0: Write your name, an integer variable, a floating-point variable, and double-precision variable on the screen.

Q1a. Print 10 random numbers between 0 and 1 on your screen., using double precision variables. Use the inbuilt random number generator of fortran.

Q1b. Print the 10 random numbers in a file named “test_ran.dat” in a column.

Q1c. Write the comment “Changing seed and generating 10 new random numbers” at the end of the file.

Q1d. Change the seed, and print 10 new random number in the file test_ran.dat.

(So, I should be able to see 10 random nos. of 1b, followed by the comment of 1c, and then 10 new random numbers).

Then change seed 10 times, generate 10 random numbers for each seed. Use format statement to open a file “test_ran_10_seeds.dat” such that one can write 10 columns in it. Write the ten random numbers for each seed in a different column. So, the file should have 10 columns, and 10 rows. Look up formatting statements further so that you have 10 digits after the decimal. You may want to use a 10x10 array, before writing them in file: test_ran_10_seeds.dat.

Q1e. In test_ran.dat, write “NOW calculating average of 10 random numbers” and calculate the average of 10 random numbers.

Q1f. Next, Calculate the average of 100, 10000, 1000000 random numbers, write down in the file.

Q1g. Calculate the difference between 0.50d0 and the mean values calculated in 1f, take the absolute value abs(--) and print. What do you see? Any comment or analysis?

Q1h. Calculate the sum of 10000 random numbers between 0 and 1, and calculate the sum 10K times. Plot the distribution of the sum. (you shall need arrays now). In the next step, normalize the distribution, so that the sum of the distribution is 1 Chose different bin sizes to plot the distribution: dx =0.5, 1, 2. Embed the 3 plots (with axis labels and legends) in a file dist_sum_random.docx, generate .pdf of the plots and upload the .pdf to google classroom. You can also calculate the sum of 10000 random numbers between -1 and +1, generate the sum 10,000 times and 100,000 times and plot the normalized distribution on the same graph for comparison.

Q1i. Generate random numbers such that they are either +1 or -1. Calculate the sum of such 10000 random nos. Plot the distribution of 10000 such sums in dist_sum_random_walk.pdf. The remaining plots hereafter should also be in dist_sum_random_walk.pdf

BTW: you are now studying the random walk problem, and you are generating 10000 random walks. Also, you see the distribution of the end points of 10000 independent random walks, where each random walk consists of 10000 steps. The distribution of the end point of 10000 independent random walks can be understood and analyzed by Central limit Theorem.

While plotting the distribution, you chose a bin size of 1. Is there something odd the in the distribution, which does not match with your intuition of what you expect from a random walk problem.

You might also get a spurious peak if you use the **int** command to generate the distribution. How will you correct for it? Maybe you should choose some other Fortran (or C) command.

Q1j: The Gaussian distribution you get might not be a smooth Gaussian. Change the width of the histogram bin to 2, 5, and 10 and see if the distribution looks any different.

If you keep the bin width the same as above, but the bins are chosen as -1 to 1, 1-3, 3 to 5 and so on (instead of -2 to 0, 0 to 2, 2 to 4 and so on), do you see any difference?

Normalize the distribution to calculate the probability of finding the end of a random walk between x and x+dx.

Q1-k. Alternatively keeping the same bin size as before, look at the distribution of 10^5 random walks, where each random walk has 10000 steps.

Q1-l: Generate 10^5 random walks with 10^5 steps, and plot the distribution of the sum, suitably normalized such that sum of the distribution is 1.

Q1m. Fit a Gaussian and calculate the variance and standard deviations for all the cases. Show the fit.

The answers of questions 1f to 1m could be nicely plotted, labelled, add comments so that it is easy to understand and submitted as part of assignment 1. Ensure that all matches with your intuition about what you already know about random walks.