

MECH 5970/6970 (GPS) Homework #1

Due: 1/31/2025

1. Chapter 1, Problem 1-4

2. Generate two random sequences that are 100 long and randomly comprised of ± 1 . There are several ways to do this using the normal Gaussian random signal generator (randn) or the uniformly distributed random signal generator (rand):

```
>>2*ceil(rand(100,1)-0.5)-1
```

```
>>2*ceil(0.1*randn(100,1))-1
```

- a) Plot the histogram on each sequence
- b) Plot the spectral analysis on each sequence

There are multiple methods to make the Power Spectral Density (PSD):

```
>>periodogram(X)                    >>pwelch(X>window_filter)                    >>plot(abs(fft(X)))
```

- c) Plot the autocorrelation each sequence with itself (i.e. a sequence delay cross correlation). I recommend you write code to do this and check again matlab functions
- d) Plot the cross autocorrelation between the two sequences. **Bonus:** Perform a Monte Carlo Simulation by repeating the cross autocorrelation between the first sequence and 100 different sequences (finding the mean and standard deviation)
Bonus: Repeat parts a-d for a sequence that is 1000 long and compare to above.

3. Generate 3 sequences 1000 long (this is a simple Monte-Carlo simulation)

```
A=3+3*randn(1000,1)
```

```
B=5+5*randn(1000,1)
```

```
C=A+B
```

```
D=3A+4B
```

```
E=3A-4B
```

```
DATA=[A B C D E]
```

- a) Find the mean (>>mean) and variance (>>std or >>var) for A, B, C, D, and E
- b) Find the mean of DATA
- c) Find the Covariance Matrix of DATA (>>cov)

4. Develop the Taylor Series linearized approximation the following equation

$$r(x, y) = \sqrt{(x - a)^2 + (y - b)^2}$$

5. Write code to perform a time autocorrelation of a 1 Hz sine wave. Plot the result (from -1 seconds to +1 seconds) and the normalized result.