ELEG 5693 Assignment # 1

1. Using Matlab to plot continuous-time function. Read, execute, and understand the folloing Matlab codes:

```
% Matlab cannot represent continous-time functions
% (e.g. sin(t)). To solve this problem, we use discrete-time
% variables with very small time interval to approximate
% continuous-time function. The small time interval
% is called time domain resolution.

% the time domain resolution we are going to use is 0.01 second.
t_res = 0.01;

% create vector starting from 0 and ending at 2,
% the distance between consecutive samples is t_res
% the discrete-time vector is used to approximate
% continuous time from -2 sec to 2 sec
t = [0:t_res:2];

% the freqeuncy is 3 Hz
f = 2;

% the initial phase is 0
theta_0 = 0;

% define the function
y = sin(2*pi*f*t+theta_0);

% draw the function with t on the x-axis and y on the y-axis.
plot(t, y);
```

Using the above Matlab codes as example, draw the following two functions in ONE figure (use the command "hold on")

(a) $\sin(4t+2)$, $-5 \leq t \leq 5$

(b) $\exp(-3t)$, $0 \leq t \leq 3$

You can use the command **axis()** to adjust the range of the axese to make the plot look better.

2. The Matlab command **rand(m, n)** will generate an $m \times n$ matrix, with each element being uniformlly distributed in the range of $[0, 1]$. The elements in the matrix are independent and identically distributed (i.i.d.).

   (a) Let the RV A be uniformly distributed in the range of [3, 5], *i.e.*, $X \in U[3, 5]$. Find the mean and variance of X.

   (b) Using Matlab, generate a size 1×100000 vector with the elements satifying $X \in [3, 5]$.

   (c) Use the command **mean(A)** to evaluate the mean of the RVs. Compare the results from Prob. 2a

   (d) Based on the definition of variance, write your own function to find out the variance of the RVs in A, save it in varnew.m (use "**help function**" to get more information about write your own function). The input of the function is a random vector, and the output of the function is the variance of the vector.

   (e) Evaluate the variance of A with your own function as **varnew(A)**.

   (f) Use the Matlab built-in command **var(A)** to evaluate the variance of the RVs. Compare the results from Prob. 2e and 2a.

   (g) Use the function **[y, x] = pdf(A)** (the function pdf.m can be downloaded from the course website) to evaluate the empirical pdf of the random valriables in A. Plot the pdf with **x** being the x-axis and **y** being the y-axis. Use the command **axis([2, 6, 0, 2]** to set the range of the axese. In the same figure, plot the theroretical pdf of $U(3, 5)$. Compare the results.

3. The Matlab command **randn(m, n)** will generate an $m \times n$ matrix, with each element being Gaussian distributed with mean 0 and variance 1. The elements in the matrix are independent and identically distributed (i.i.d.).

   (a) Using Matlab, generate a size 1×100000 vector with the elements being Gaussian distributed with mean 2 and variance 3.

   (b) Use the command **mean(B)** to evaluate the mean of the RVs. Compare the results with its theoretical value.

   (c) Use the command **varnew(B)** to evaluate the variance of the RVs. Compare the results with its theoretical value.

   (d) Use the function **[y, x] = pdf(B)** to evaluate the empirical pdf of the random valriables in B. In the same figure, plot the theroretical pdf of $\mathcal{N}(2, 3)$. Compare the results.