Communications and Information Engineering Program
Probability and Stochastic Processes (CIE 327)
Project (Stochastic Processees)

PART I: STOCHASTIC PROCESSES CALCULATOR

It is required to create a GUI-based tool that allows a user to enter any stochastic process and results it ensemble and time statistics of such process. The GUI can be built using Matlab or any other software package.

GUI Description

The GUI should do the following:

1) Allow the user enter a random process in the form of the ensemble, i.e. all the sample functions, each defined by two vectors; time and amplitude. Note that the time vector can be common to all the sample functions.
2) Give the use to perform and display the following:
   - Plot M sample functions of the ensemble of the process, where M is entered by the user
   - Calculate and plot the ensemble mean of the process
   - Calculates the time mean of the n^{th} sample function of the process, where n is entered by the user
   - Calculate and plot the statistical auto-correlation function between the i^{th} sample and the j^{th} sample of the process, where i and j are entered by the user
   - Calculate the time auto-correlation function of the n^{th} sample function of the process, where n is entered by the user
   - Calculate and plot the power spectral density of the process
   - Calculate the total average power of the process

Testing your GUI

Test your GUI for the random process $X(t)$

$$X(t) = A\cos(\omega_c t + \theta)$$

Start using the following Matlab lines:

theta = **unifrnd(-pi,pi,1000);**
omega-c = **2*pi;**
A = **5;**
t = **[-5:0.01:5];**

Deliverable - Part I

Deliver the following:

1) An executable file for the GUI
2) All the source codes (**.m** files)
3) The outputs of the GUI for the test stochastic process as follows:
   - A plot of 5 random sample functions of the process $X(t)$, each plotted in a different subplot.
   - A plot of the ensemble mean of $X(t)$
   - Comment on the previous plot
   - A 3D plot of the ACF between i^{th} sample and the j^{th} sample for every i and j.
     Hint: This is a 3D plot, where the horizontal axes are i and j, and the vertical axis in the value of the ACF
   - Comment on the previous plot
   - The value of the time average and the time ACF of a random sample function.
   - Is there a relation between the statistical mean and the time mean, for the test process? Comment
   - Is there a relation between the statistical ACF and the time ACF, for the test process? Comment
   - Plot the PSD of the process
   - A complete .pdf report documenting all the previous outputs, with proper titles, subtitles, labeling, captioning and commenting.

PART II: BINARY STOCHASTIC PROCESSES

It is required to use the previously created GUI to study binary stochastic processes.

Description

Using the GUI in Part I, plot the ACF and the PSD of the following binary stochastic processes:

1) Polar NRZ process
2) Unipolar NRZ process
3) Manchester process

For all of the processes above, use the following parameters:

- Amplitude, $A = 1$ volt
- Bit duration, $T_b = 1, 10, 100$ seconds
- Number of bits, $N = 100$
- Initial time shift, $\alpha \sim \mathcal{U}(0, T_b)$

Deliverable - Part II

For **each** of the binary processes above:

1) Source code used for the Generation of the random process
2) A plot of 5 random sample functions of the process, each plotted in a different subplot.
3) A figure containing 3 horizontal subplots for the ACF for $T_b = 1, 10, 100$ second, and 3 other horizontal subplots for the PSD for $T_b = 1, 10, 100$ second.
4) Comment on the previous figure
5) For the case of $T_b = 10$ seconds, which of the three processes has a larger bandwidth?
6) A complete .pdf report documenting all the previous outputs, with proper titles, subtitles, labeling, captioning and commenting.

GENERAL INSTRUCTIONS & GRADING CRITERIA

Instructions

1) This is an individual project.
2) Reports are not to be shared with others.
3) Any copied reports, either fully or partially, will receive 0 points. This applies to both the original and the copy.
4) Late submission will be penalized at the rate of 15% per day for a maximum of 2 days, after which no submissions will be considered.

Grading Criteria

Grading of each part will depend on:

- **60%:** Completeness and correctness of the deliverable.
- **20%:** Clarity of figures, and proper labeling.
- **20%:** Report writing and organization.