

## ANALYSIS OF STOCHASTIC PROCESSES

It is required to create a GUI-based tool that allows a user to enter any stochastic process and results in the ensemble and the 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.

**An example .m file of the ensemble is attached.**

- 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 processes  $X(t)$  and  $Y(t)$ , where,

- $X(t)$  is defined as in the attached sample file.
- $Y(t)$  is defined as

$$Y(t) = A \sin(\omega_c t + \theta) + 0.5 A \cos(2\omega_c t + \theta/3)$$

Start using the following Matlab lines:

```
theta = unifrnd(0,2*pi,1000);  
omega-c = 3/4*pi;  
A = 4;  
t = [-10:0.01:5];
```

### ***Deliverable***

Deliver the following:

- 1) An executable file for the GUI
- 2) All the source codes (.m files)
- 3) The outputs of the GUI for both the test stochastic processes,  $X(t)$  and  $Y(t)$ , as follows:
  - A plot of 5 random sample functions of the process, each plotted in a different subplot.
  - A plot of the ensemble mean
  - 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 is 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.
- 4) A video recording showing the running GUI and how it is used to generate the required plots.

## **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 10% per day for a maximum of 5 days, after which no submissions will be considered.

### ***Grading Criteria***

Grading of each part will depend on:

- **60%**: Completeness and correctness of the deliverable.
- **10%**: Clarity of the GUI design and ease of use.
- **20%**: Report writing and organization.
- **10%**: Comprehensiveness and clarity of content in the recorded video.