Zewail City of Science and Technology
University of Science and Technology
CIE 327 – Probability and Stochastic Processes

Project Report
Part I

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Part I

(1) **The Matlab functions:**

(1)

```
function s_mean = stat_mean(X)
%% For the statistical mean
P = 1/size(X,1);
s_mean=sum(X,1)*P;
end
```

(2)

```
function TIME_MEAN = time_mean(X,n)
% This function gets a matrix X of waveforms represent a random process
% The output is the time mean of the nth waveform specified by the input n
TIME_MEAN = (1/size(X,2))*sum(X(n,:));
end
```

(3)

```
function result=stat_acf(X,k,t)
% k, t are the points we get the autocorrelation for.
result=0;
P = 1/size(X,1);
        for j=1:1:size(X,1) %Rows
        result=result+X(j,k)*X(j,t)*(P^2);
        end
end
```

(4)

```
function R=time_acf(X,n)
% n is the number of waveform specified
c = size(X,2);
W = X(n,:);
R=zeros(1,2*c);
for tau=1:c
        for t=1:c
        if t+tau<=c
        R(tau) = R(tau) + W(t)*W(t+tau);
        end
        end
end
R = R(1,1:c); %The final output (to ignore the zeros)
end
```

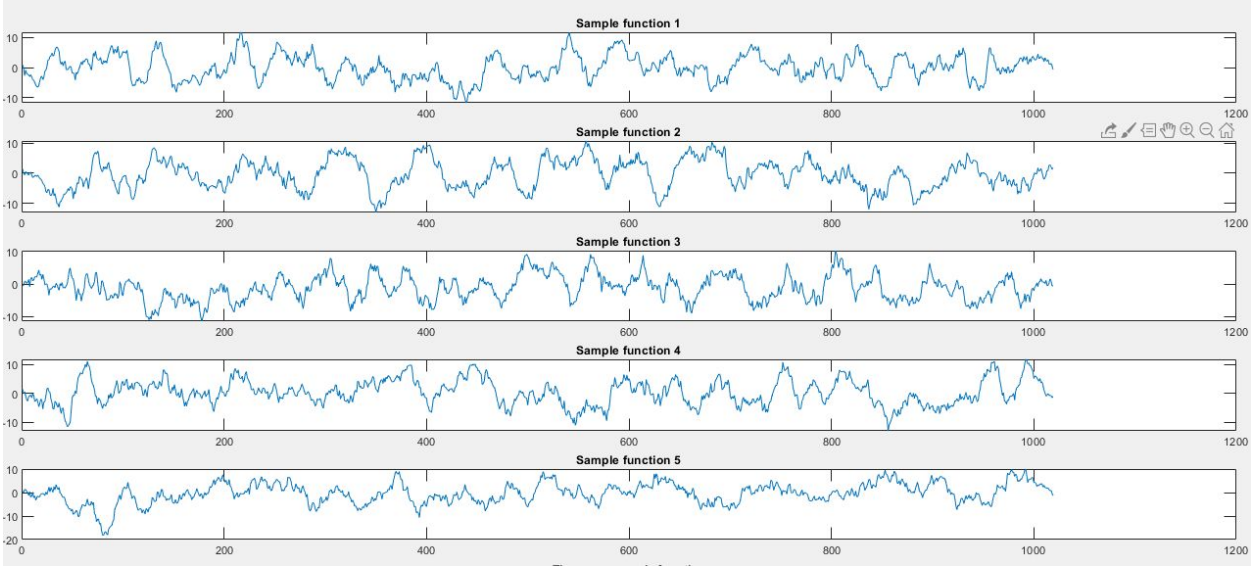
(5)

```
function total = total_power(X)
P = 1/size(X,1);
total=(sum(X,1).^2).*P;
end
```

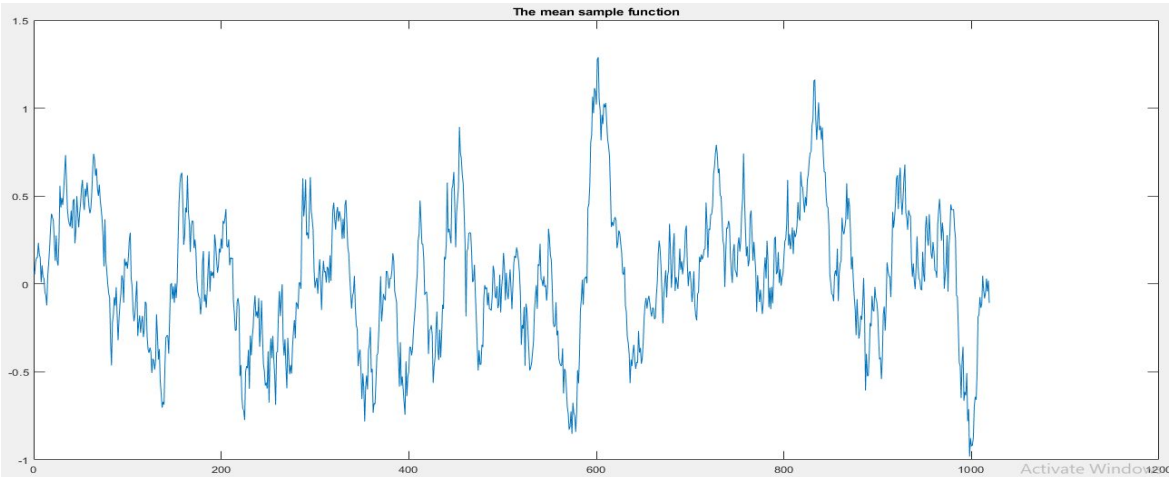
(6)

```
function result = PSD(X)
c=size(X,2);
s_acf = zeros(1,c);
for i=1:1:c
  s_acf(1,i)=stat_acf(X,c,i);
end
 result = fft(s_acf);
end
```

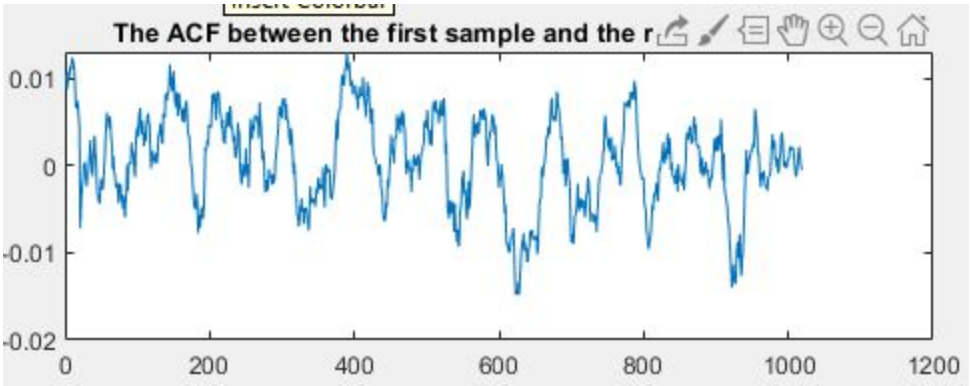
(2) A plot of 5 Sample Functions:



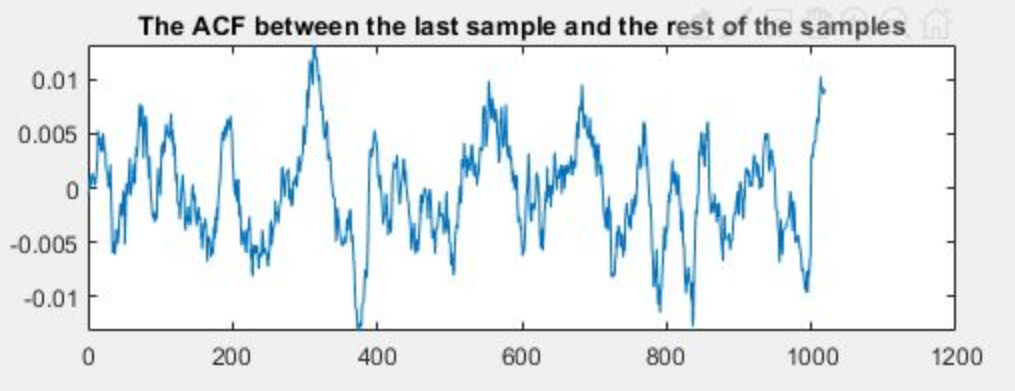
(3) A plot of the Mean Sample Function:



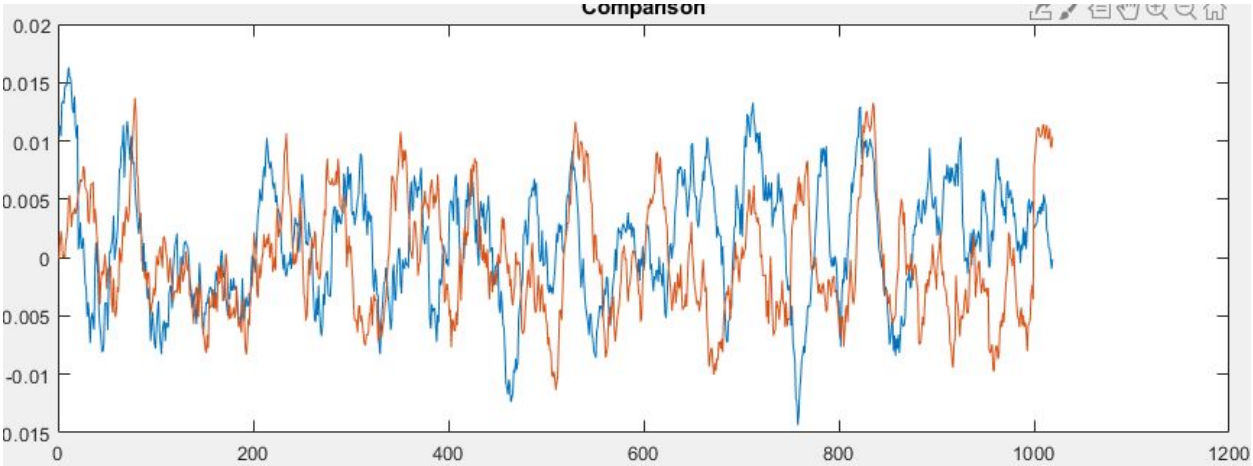
(4) ACF between the first sample and the rest of samples



(5) ACF between the last sample and the rest of samples



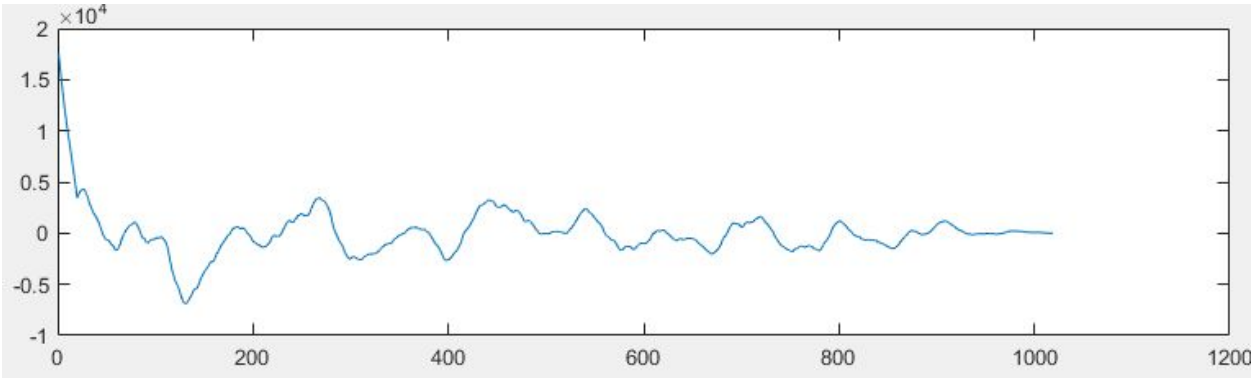
Comparing to the previous plot, the correlation is different along the different points. Of course, the correlation between the last points in the second plot must be higher than the first plot and vise versa between the first points.



(6)

Time average of the 1st sample function =0.1347

Time ACF of the 1st sample function,



(7) **Relation between statistical mean and time mean**

Statistical mean is the average waveform that occurs in the total random process, while the time mean is the average sample in specific waveform.
In my results: the statistical mean is not constant value that equals the time mean so that the random process cannot be ergodic.

(8) **Relation between statistical ACF and time ACF**

The waveform of the time ACF is smoother than the waveform of the statistical waveform, this means that the values of the neighbouring samples is much nearer than the values of each sample in the total waveforms and its neighbours.