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EECS 4214 Lab 2

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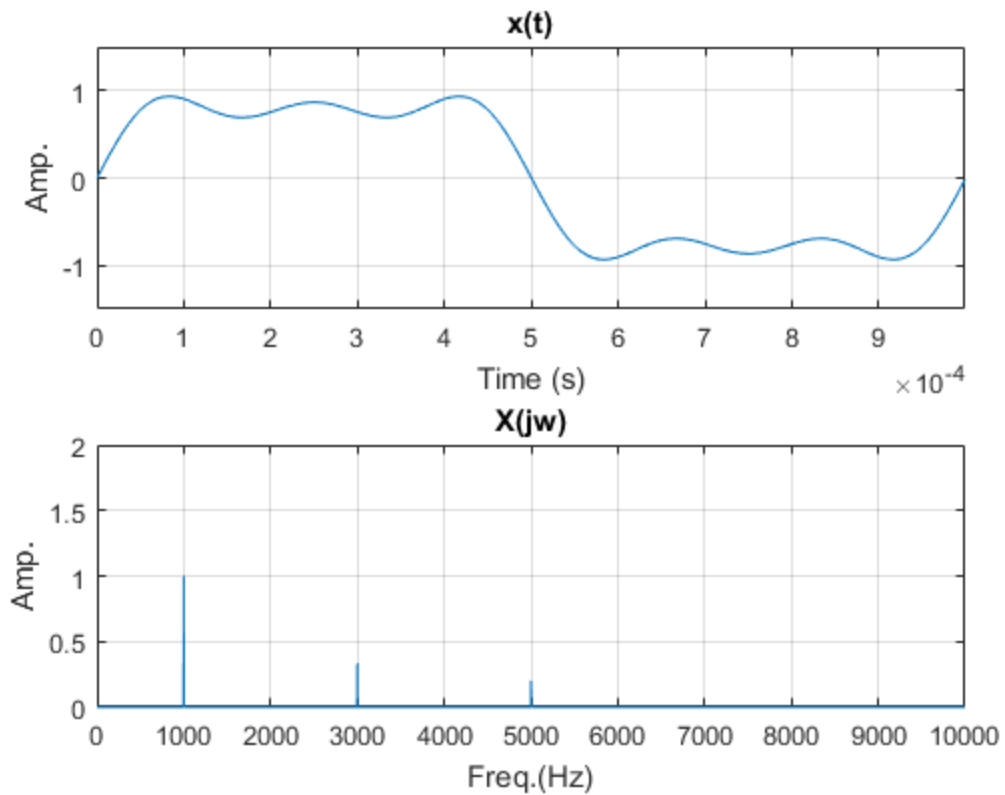
Problem 1

```
clc;
close all;
clear all;

%Time Domain
t=0:1e-6:1;
f1=1e3;
x=sin(2*pi*f1*t)+(1/3)*sin(2*pi*3*f1*t)+(1/5)*sin(2*pi*5*f1*t);
subplot(2,1,1);
plot(t,x);
axis([0 0.999e-3 -1.5 1.5]);
title('x(t)');
xlabel('Time (s)');
ylabel('Amp. ');
grid;
%Freq. Domain
subplot(2,1,2);

%Normalize FFT
X=fft(x);
X=X/length(x);
X = X(1:length(X)/2+1);
X(2:end-1) = 2*X(2:end-1);
f = linspace(0,1e6/2,length(X));
plot(f,abs(X));
axis([0 10000 0 2]);
title('X(jw)');
xlabel('Freq. (Hz)');
ylabel('Amp. ');
grid;
```

Warning: Integer operands are required for colon operator when used as index



Problem 2

```
clc;
close all;
clear all;

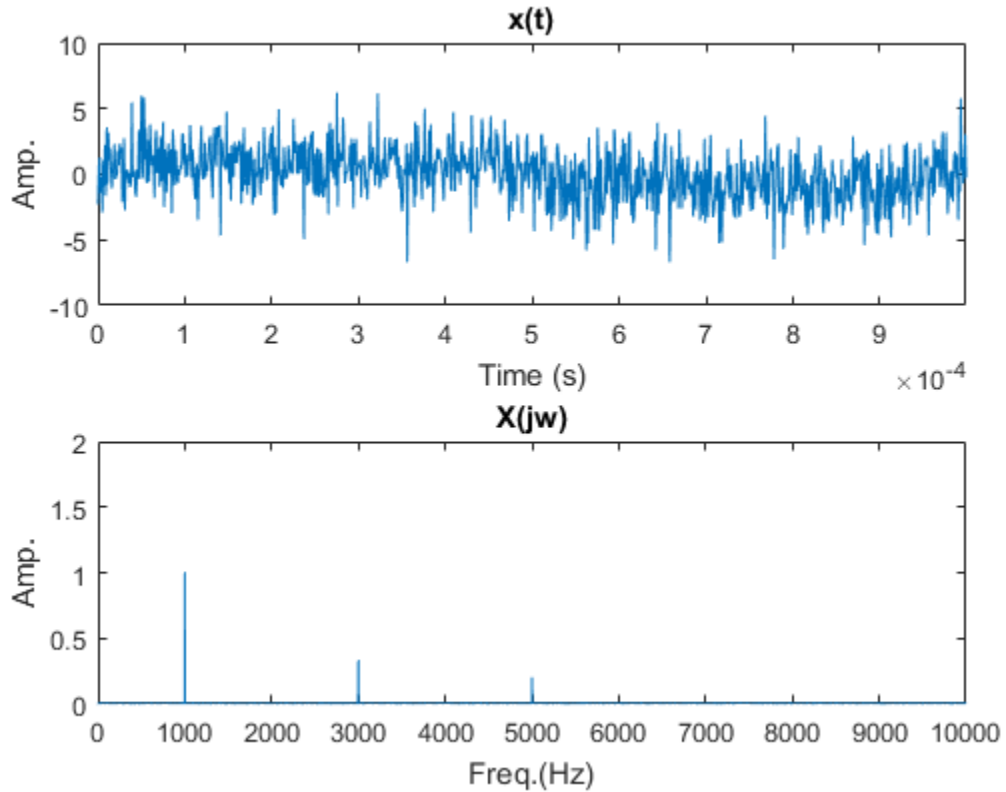
%Time Domain
t=0:1e-6:1;
f1=1e3;
x=sin(2*pi*f1*t)+(1/3)*sin(2*pi*3*f1*t)+(1/5)*sin(2*pi*5*f1*t);
x=x+2*randn(1,length(t));
subplot(2,1,1);
plot(t,x);
axis([0 0.999e-3 -10 10]);
title('x(t)');
xlabel('Time (s)');
ylabel('Amp. ');

%Freq. Domain
subplot(2,1,2);

X=fft(x);
X=X/length(x);
X = X(1:length(X)/2+1);
X(2:end-1) = 2*X(2:end-1);
```

```
f = linspace(0,1e6/2,length(X));  
plot(f,abs(X));  
axis([0 10000 0 2]);  
title('X(jw)');  
xlabel('Freq.(Hz)');  
ylabel('Amp.');
```

Warning: Integer operands are required for colon operator when used as index



Problem 3

```
clc;  
close all;  
clear all;  
vars=randn(100,1000);  
  
%time averages  
ta=mean(vars(ceil(rand*100),:));  
tb=mean(vars(ceil(rand*100),:));  
tc=mean(vars(ceil(rand*100),:));  
  
%ensemble averages  
ea=mean(vars(:,ceil(rand*1000)));  
eb=mean(vars(:,ceil(rand*1000)));  
ec=mean(vars(:,ceil(rand*1000)));
```

```
fprintf('Time Average 1: %f\n', ta);
fprintf('Time Average 2: %f\n', tb);
fprintf('Time Average 3: %f\n', tc);

fprintf('Ensemble Average 1: %f\n', ea);
fprintf('Ensemble Average 1: %f\n', eb);
fprintf('Ensemble Average 1: %f\n', ec);

fprintf('The ensemble values are fairly close to the time averages
(near 0) considering the sample size; therefore the process is
ergodic. \n');
```

Time Average 1: -0.053688
Time Average 2: 0.071763
Time Average 3: 0.064217
Ensemble Average 1: 0.000735
Ensemble Average 1: -0.153221
Ensemble Average 1: -0.214709
The ensemble values are fairly close to the time averages (near 0)
considering the sample size; therefore the process is ergodic.

Problem 4

```
clc;
close all;
clear all;

%animation can skip
figure();
%%WARNING: CTRL_C to quit out of animation
syms y(t);
y(t) = piecewise(1<t<3, 1, 3<t<4, -1, 0);
subplot(2,1,1);
fplot(y(t), 'r');
hold on;
axis([-4.5 9.5 -2 2]);
ylabel('Amplitude');
xlabel('Time(s)');
title('x(t)');
subplot(2,1,2);
hold on;
axis([-5 5 -2 4]);
ylabel('Amplitude');
xlabel('T(s)');
title('R(T)');
for shift=-5:0.1:5
    subplot(2,1,1);
    f=fplot(y(t+shift), 'b');
    legend('x(t)', 'x(t+T)');
    subplot(2,1,2);
    sumz=0;
    for count=-4.5:0.1:9.5
```

```

        if (y(count)~=0&&y(count+shift)~=0)
            sumz=(y(count)*y(count+shift))*0.1+sumz;
        end
    end
    plot(shift,sumz,'g.');
    pause(0.01);
    delete(f);
end

%Rx plotted using piecewise function
figure();
syms Rx(T);
Rx(T) = piecewise(-inf<T<-3, 0, -3<T<-2, -3-T, -2<T<-1, 1+T, -1<T<0,
    3+3*T,0<=T<1, 3-3*T, 1<T<2, 1-T, 2<T<3, -3+T, 0);
fplot(Rx(T));
axis([-5 5 -2 4]);
ylabel('Amplitude');
xlabel('T(s)');
title('R(T)');

%Hand written
figure();
imshow('autocorrelation.png');

```

Warning: Image is too big to fit on screen; displaying at 6%

