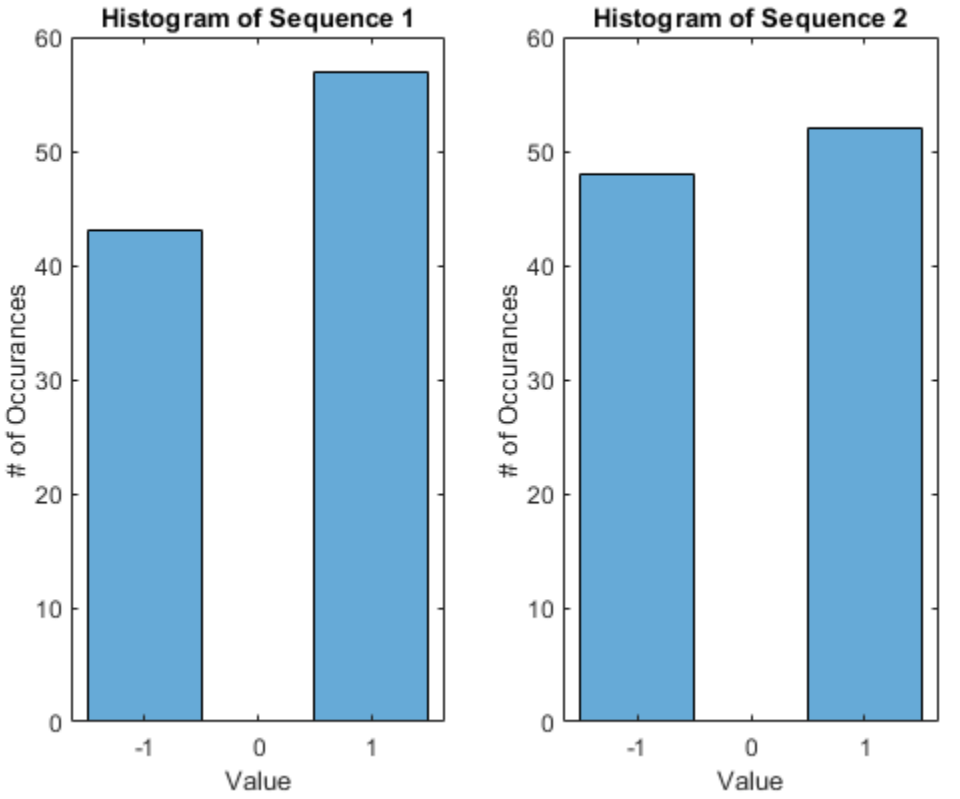
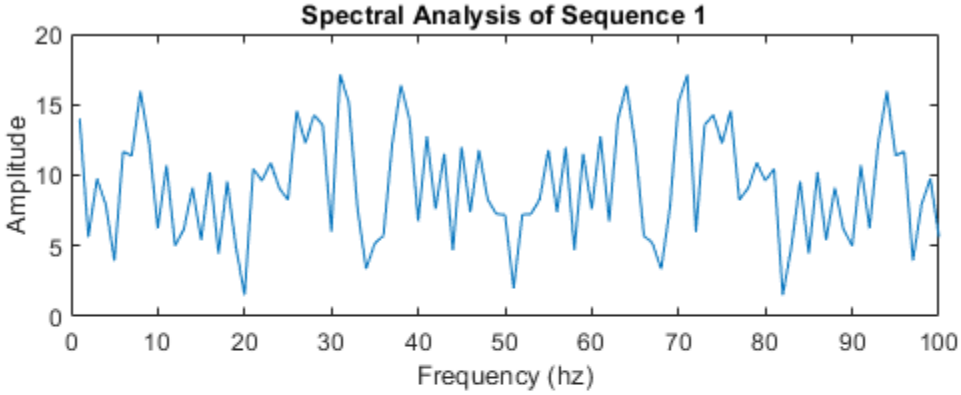
```
clear;clc;close all
```

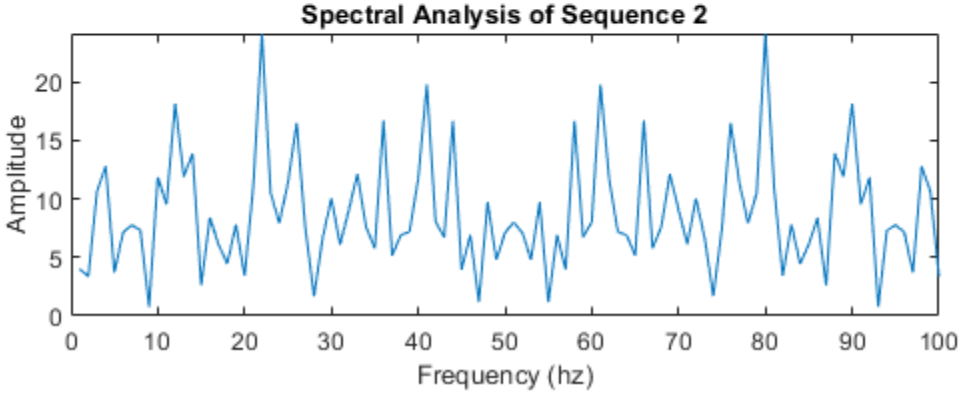
Problem 2

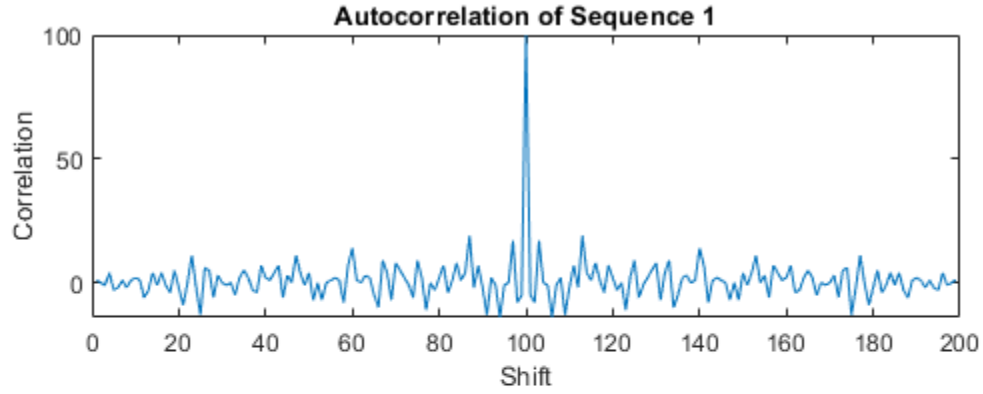
```
seq1 = 2*ceil((rand(100,1)-.5))-1;
seq2 = 2*ceil((rand(100,1)-.5))-1;

% Part A - Plot Histogram of Each Sequence

figure
subplot(1,2,1)
histogram(seq1)
title("Histogram of Sequence 1")
xlabel("Value")
ylabel("# of Occurances")
subplot(1,2,2)
histogram(seq2)
title("Histogram of Sequence 2")
xlabel("Value")
ylabel("# of Occurances")

% Part B - Plot Spectral Analysis of Each Sequence

figure
subplot(2,1,1)
plot(abs(fft(seq1)))
title("Spectral Analysis of Sequence 1")
xlabel("Frequency (hz)")
ylabel("Amplitude")
subplot(2,1,2)
plot(abs(fft(seq2)))
title("Spectral Analysis of Sequence 2")
xlabel("Frequency (hz)")
ylabel("Amplitude")

% Part C - Plot Autocorrelation for Each Sequence

aCorr1 = autoCorrelation(seq1);
aCorr2 = autoCorrelation(seq2);

figure
subplot(2,1,1)
plot(aCorr1)
title("Autocorrelation of Sequence 1")
xlabel("Shift")
ylabel("Correlation")
subplot(2,1,2)
plot(aCorr2)
title("Autocorrelation of Sequence 2")
xlabel("Shift")
ylabel("Correlation")
```

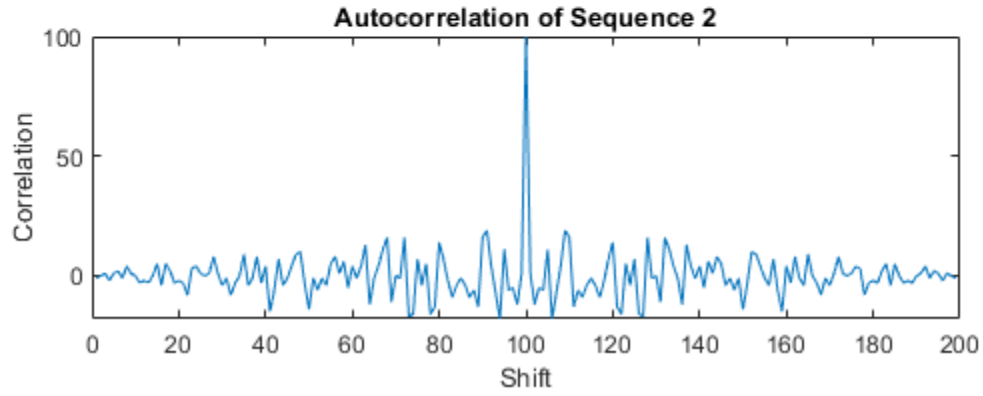
```
function aCorr = autoCorrelation(seq)

    n = length(seq);
    m = 2*n-1;
    for i = 1 : n
        aCorr(i) = sum(seq(n-i+1:n) .* seq(1:i));
        aCorr(m+1-i) = aCorr(i); % autocorrelation is symmetric
    end
end

% Part D - Plot Cross Correaltion Between the Two Sequences

xCorr = crossCorr(seq1,seq2);
figure
plot(xCorr)
title("Cross Correlation of Sequence 1 & 2")
xlabel("Shift")
ylabel("Correlation")

function xCorr = crossCorr(seq1,seq2)

    n = length(seq1);
    for i = -n : n
        if i < 0
            xCorr(i+n+1) = sum(seq1(1:end+i) .* seq2(-i+1:end));
        elseif i > 0
            xCorr(i+n+1) = sum(seq1(1:end-i) .* seq2(i+1:end));
        else
            xCorr(i+n+1) = sum(seq1 .* seq2);
        end
    end
end
```

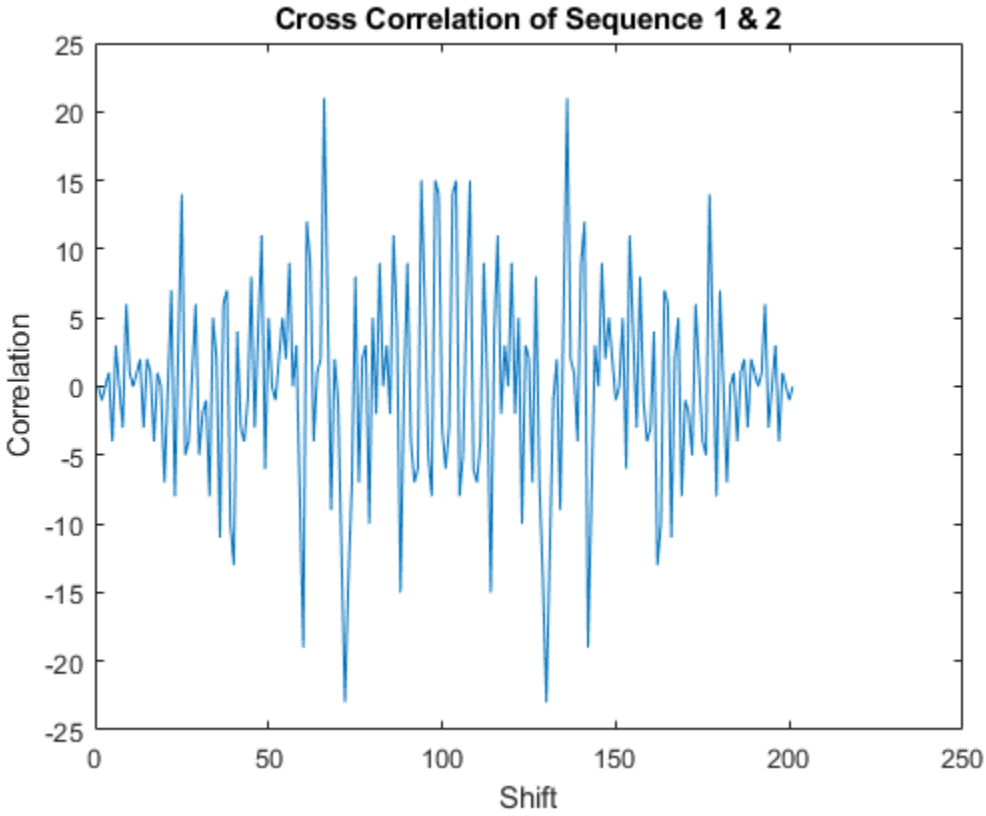

Histogram of Sequence 1
# of Occurances
Value
Histogram of Sequence 2
# of Occurances
Value


Spectral Analysis of Sequence 1
Amplitude
Frequency (hz)


Spectral Analysis of Sequence 2
Amplitude
Frequency (hz)


Autocorrelation of Sequence 1
Correlation
Shift
100
50
0
0
20
40
60
80
100
120
140
160
180
200

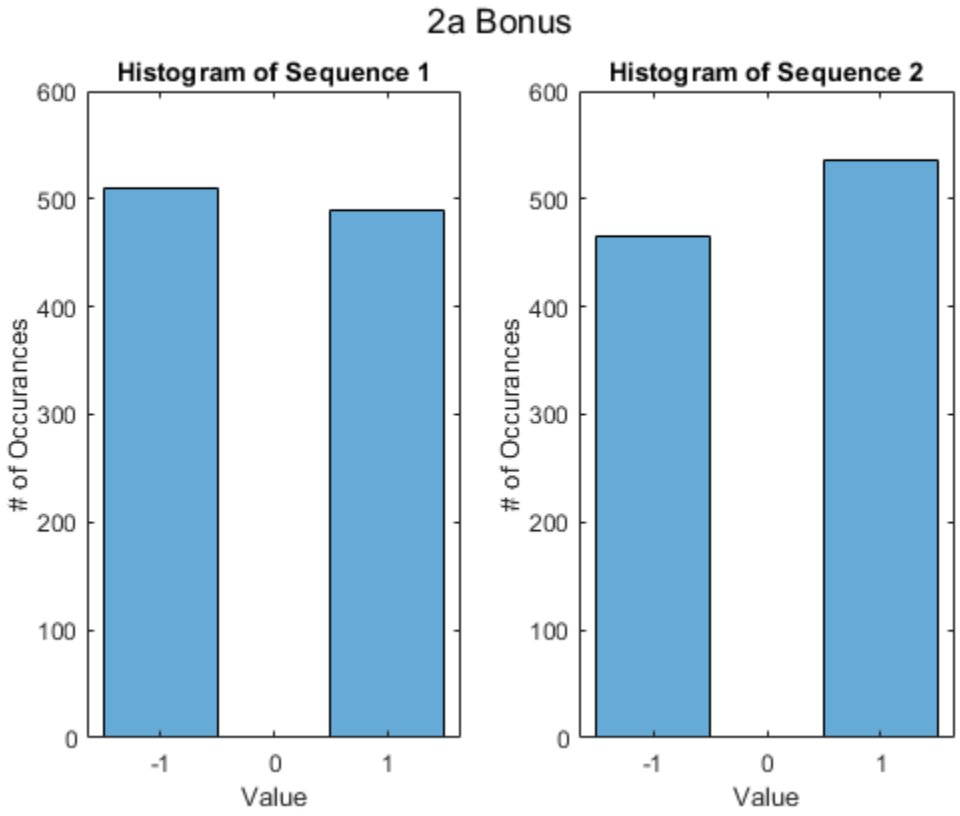

Autocorrelation of Sequence 2
Correlation
Shift
100
50
0
0
20
40
60
80
100
120
140
160
180
200


Cross Correlation of Sequence 1 & 2
Correlation
Shift
25
20
15
10
5
0
-5
-10
-15
-20
-25
0
50
100
150
200
250

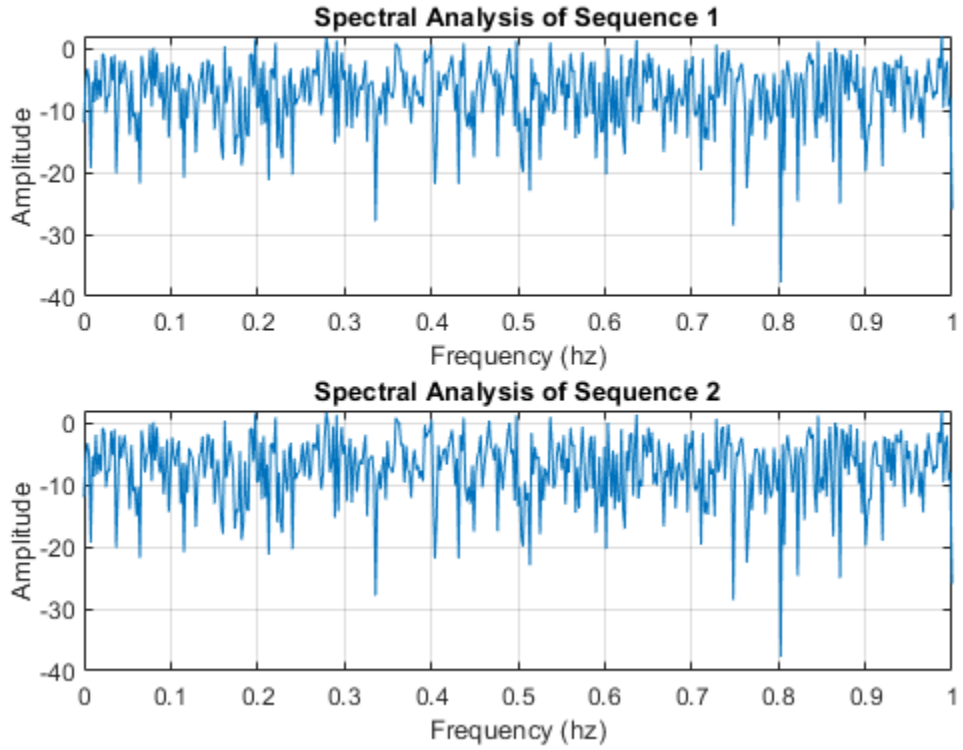
Problem 2 Bonus

```
seq1 = 2*ceil((rand(1000,1)-.5))-1;
seq2 = 2*ceil((rand(1000,1)-.5))-1;

% Part A - Plot Histogram of Each Sequence

subplot(1,2,1)
histogram(seq1)
title("Histogram of Sequence 1")
xlabel("Value")
ylabel("# of Occurances")
subplot(1,2,2)
histogram(seq2)
title("Histogram of Sequence 2")
xlabel("Value")
ylabel("# of Occurances")
sgtitle('2a Bonus')

% Part B - Plot Spectral Analysis of Each Sequence

figure
subplot(2,1,1)
periodogram(seq1)
title("Spectral Analysis of Sequence 1")
xlabel("Frequency (hz)")
ylabel("Amplitude")
subplot(2,1,2)
periodogram(seq1)
title("Spectral Analysis of Sequence 2")
xlabel("Frequency (hz)")
ylabel("Amplitude")
sgtitle('2b Bonus')

% Part C - Plot Autocorrelation for Each Sequence

aCorr1 = xcorr(seq1,seq1);
aCorr2 = xcorr(seq2,seq2);

figure
subplot(2,1,1)
plot(aCorr1)
title("Autocorrelation of Sequence 1")
xlabel("Shift")
ylabel("Correlation")
subplot(2,1,2)
plot(aCorr2)
title("Autocorrelation of Sequence 2")
xlabel("Shift")
ylabel("Correlation")
sgtitle('2c Bonus')

% Part D - Plot Cross Correaltion Between the Two Sequences
```

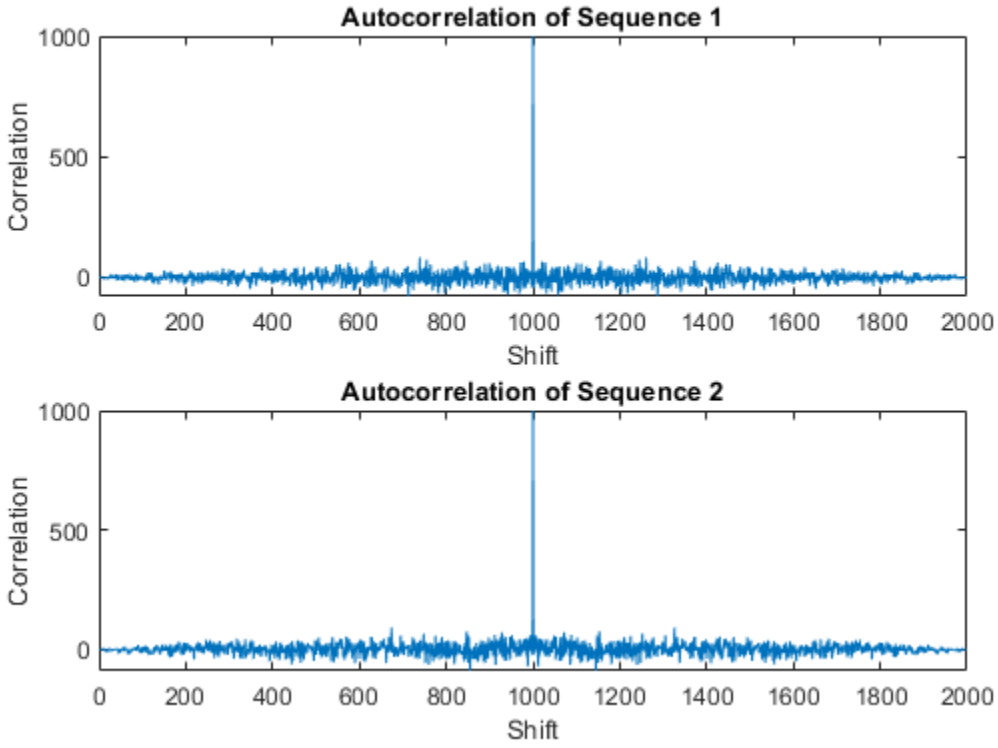
```
xCorr = xcorr(seq1,seq2);
figure
plot(xCorr)
title("Bonus - Cross Correlation of Sequence 1 & 2")
xlabel("Shift")
ylabel("Correlation")
```

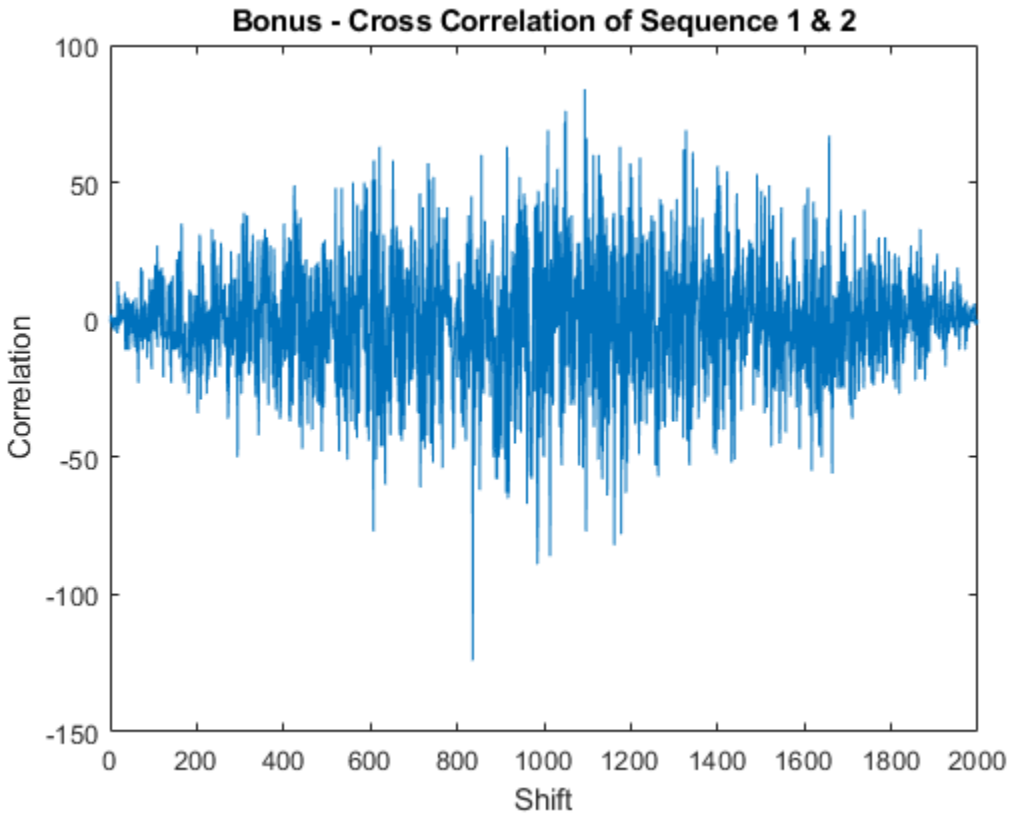


2b Bonus



2c Bonus





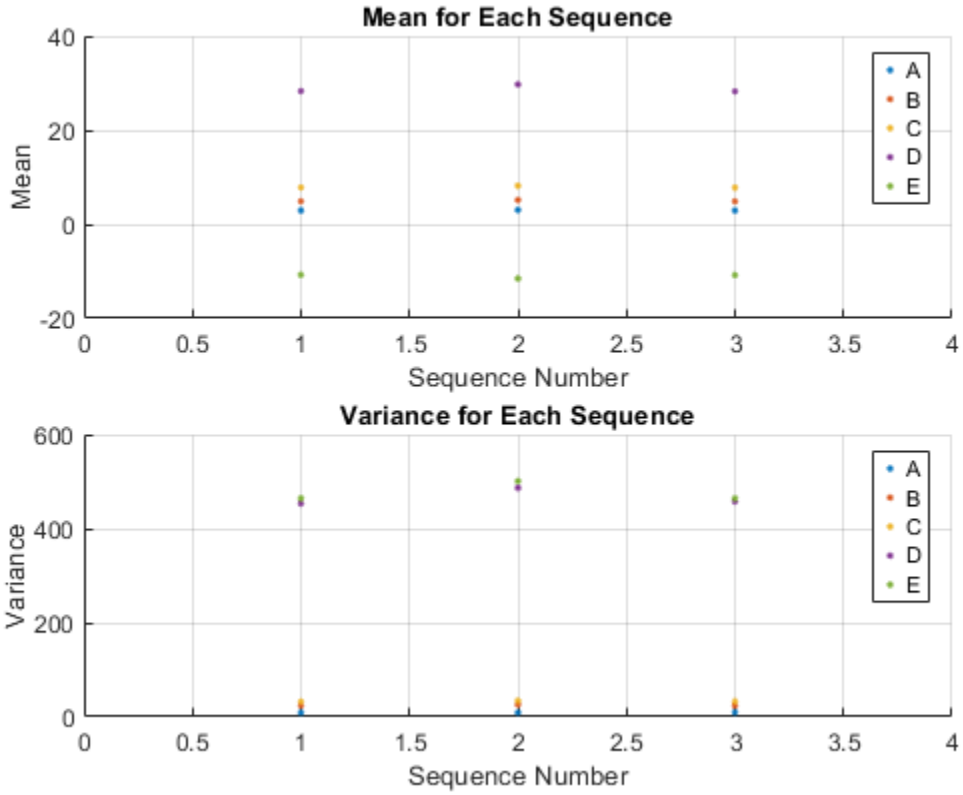
Problem 3

```
for i = 1 : 3
    A = 3 + 3*randn(1000,1);
    B = 5 + 5*randn(1000,1);
    C = A + B;
    D = 3*A + 4*B;
    E = 3*A - 4*B;

    DATA = [A B C D E];

    % Part A - Find Mean and Variance for A, B, C, D, and E

    meanA(i) = mean(A);
    meanB(i) = mean(B);
    meanC(i) = mean(C);
    meanD(i) = mean(D);
    meanE(i) = mean(E);

    varA(i) = var(A);
    varB(i) = var(B);
    varC(i) = var(C);
    varD(i) = var(D);
    varE(i) = var(E);
```

```
    meanDATA(i,:) = mean(DATA);

    covDATA(:,:,i) = cov(DATA);

    fprintf("\nSequence %g\n",i)
    fprintf("-------------------------\n")
    fprintf("Mean A = %.4f\n",meanA(i))
    fprintf("Mean B = %.4f\n",meanB(i))
    fprintf("Mean C = %.4f\n",meanC(i))
    fprintf("Mean D = %.4f\n",meanD(i))
    fprintf("Mean E = %.4f\n\n",meanE(i))

    fprintf("Var A = %.4f\n",varA(i))
    fprintf("Var B = %.4f\n",varB(i))
    fprintf("Var C = %.4f\n",varC(i))
    fprintf("Var D = %.4f\n",varD(i))
    fprintf("Var E = %.4f\n\n",varE(i))

    fprintf("Mean DATA = \n")
    fprintf("%.4f %.4f %.4f %.4f %.4f\n\n",meanDATA(i,:))

    fprintf("Cov DATA = \n")
    fprintf("%10.4f %10.4f %10.4f %10.4f %10.4f\n",covDATA(:,:,i))

end

subplot(2,1,1)
hold on
grid on
plot(meanA,'.')
plot(meanB,'.')
plot(meanC,'.')
plot(meanD,'.')
plot(meanE,'.')
title("Mean for Each Sequence")
xlabel("Sequence Number")
xlim([0,4])
ylabel("Mean")
legend('A','B','C','D','E')
subplot(2,1,2)
hold on
grid on
plot(varA,'.')
plot(varB,'.')
plot(varC,'.')
plot(varD,'.')
plot(varE,'.')
title("Variance for Each Sequence")
xlabel("Sequence Number")
xlim([0,4])
ylabel("Variance")
legend('A','B','C','D','E')
```

```
Sequence 1
--------------------------
Mean A = 2.9265
Mean B = 4.8796
Mean C = 7.8061
Mean D = 28.2977
Mean E = -10.7387

Var A = 9.1214
Var B = 23.5363
Var C = 32.1900
Var D = 453.0618
Var E = 464.2855

Mean DATA =
2.9265 4.8796 7.8061 28.2977 -10.7387

Cov DATA =
    9.1214    -0.2338     8.8875    26.4287    28.2994
   -0.2338    23.5363    23.3025    93.4439   -94.8468
    8.8875    23.3025    32.1900   119.8726   -66.5475
   26.4287    93.4439   119.8726   453.0618  -294.4893
   28.2994   -94.8468   -66.5475  -294.4893   464.2855

Sequence 2
--------------------------
Mean A = 3.0335
Mean B = 5.1562
Mean C = 8.1897
Mean D = 29.7254
Mean E = -11.5241

Var A = 8.8870
Var B = 25.8612
Var C = 34.1535
Var D = 486.6258
Var E = 500.8984

Mean DATA =
3.0335 5.1562 8.1897 29.7254 -11.5241

Cov DATA =
    8.8870    -0.2973     8.5896    25.4716    27.8503
   -0.2973    25.8612    25.5639   102.5528  -104.3369
    8.5896    25.5639    34.1535   128.0243   -76.4865
   25.4716   102.5528   128.0243   486.6258  -333.7965
   27.8503  -104.3369   -76.4865  -333.7965   500.8984

Sequence 3
--------------------------
Mean A = 2.9084
Mean B = 4.8785
Mean C = 7.7869
```

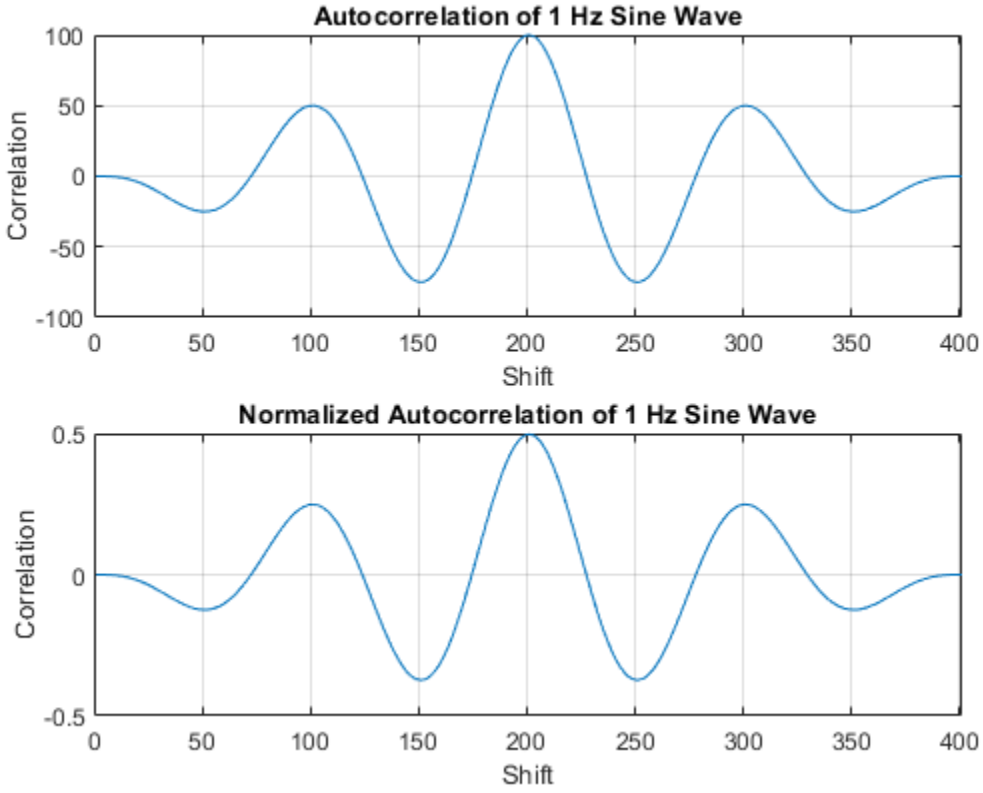
```
Mean D = 28.2394
Mean E = -10.7889

Var A = 9.4399
Var B = 23.4884
Var C = 32.6586
Var D = 457.5364
Var E = 464.0108

Mean DATA =
2.9084 4.8785 7.7869 28.2394 -10.7889

Cov DATA =
    9.4399    -0.1349     9.3051    27.7803    28.8593
   -0.1349    23.4884    23.3535    93.5489   -94.3582
    9.3051    23.3535    32.6586   121.3292   -65.4988
   27.7803    93.5489   121.3292   457.5364  -290.8547
   28.8593   -94.3582   -65.4988  -290.8547   464.0108
```



Problem 5

```
freq = 1;
t = -1 : 0.01 : 1;
func = sin(2*pi*freq*t);

aCorr = autoCorr(func);
```

```
aCorr_norm = aCorr/length(t);

figure
subplot(2,1,1)
plot(aCorr)
title("Autocorrelation of 1 Hz Sine Wave")
grid on
xlabel("Shift")
xlim([0 2*length(func)-1])
ylabel("Correlation")
subplot(2,1,2)
plot(aCorr_norm)
title("Normalized Autocorrelation of 1 Hz Sine Wave")
grid on
xlabel("Shift")
xlim([0 2*length(func)-1])
ylabel("Correlation")

function aCorr = autoCorr(seq)

    n = length(seq);
    m = 2*n-1;
    for i = 1 : n
        aCorr(i) = sum(seq(n-i+1:n) .* seq(1:i));
        aCorr(m+1-i) = aCorr(i); % autocorrelation is symmetric
    end
end
```



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