# MATLAB Homework #1

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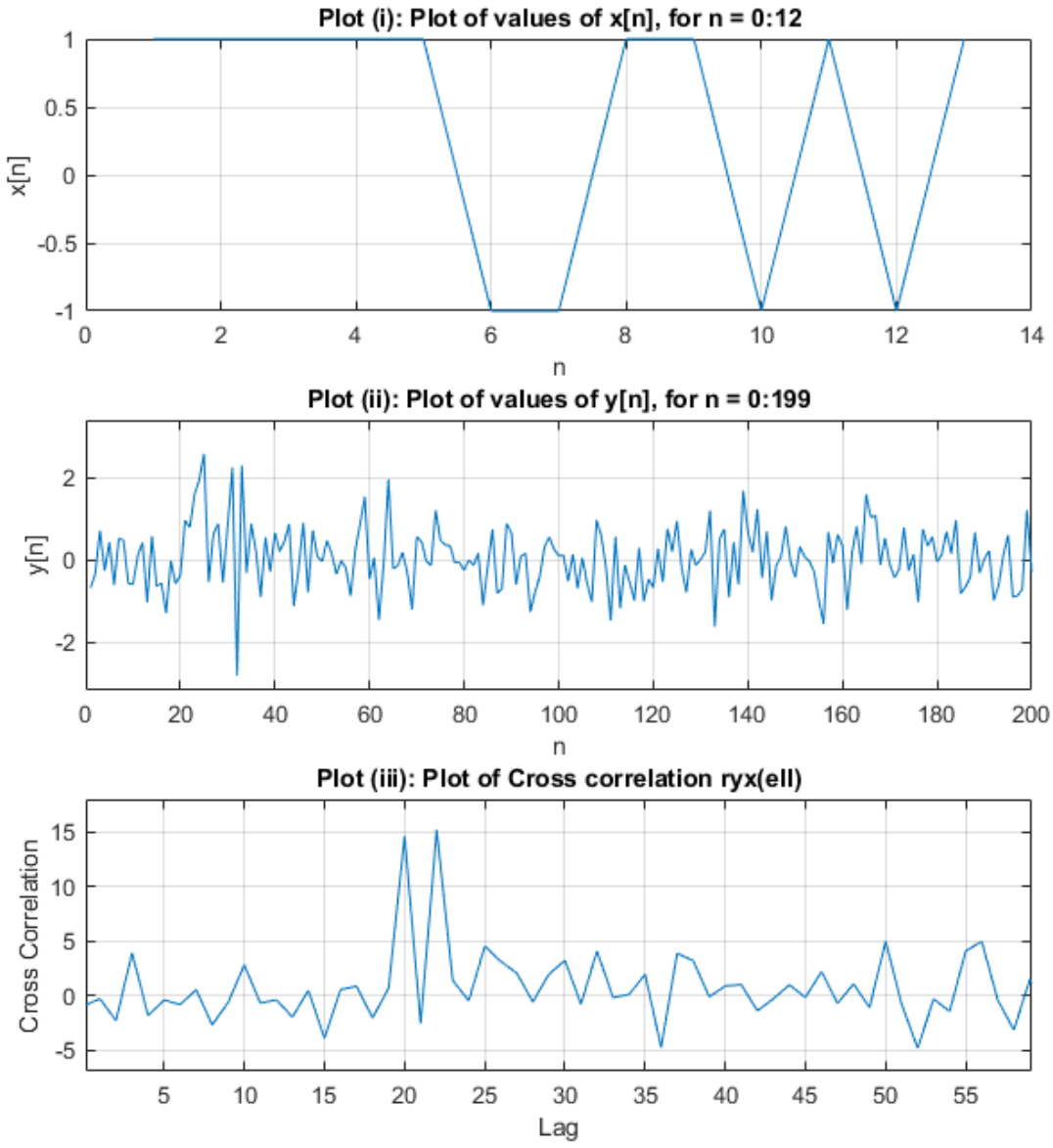
ECE 538

Digital Signal Processing I

Fall 2020

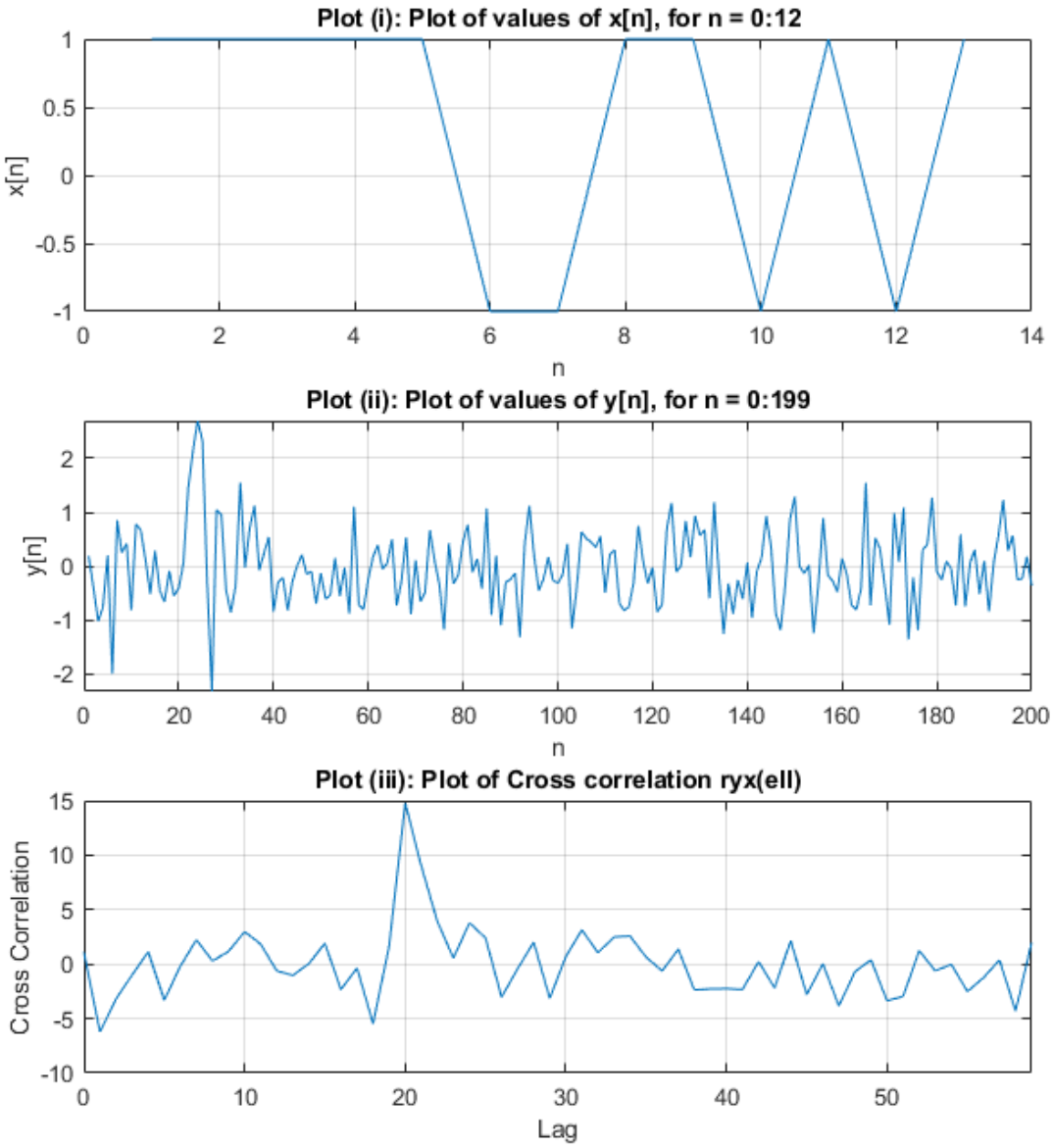
**Page 1: a2 = 1, D2 = 22, M = 13:**




Observations and explanations:

- Y[n] hits the crest a several times between n = 20, n =40, as well as hitting a trough during that period of time.
- Approximately after N = 33, there should not be a wave with significantly large amplitude, because the input x[n] only has 13 elements.
- Cross correlation plot has two distinct max amplitude around delay (lag) = 20 and 22.

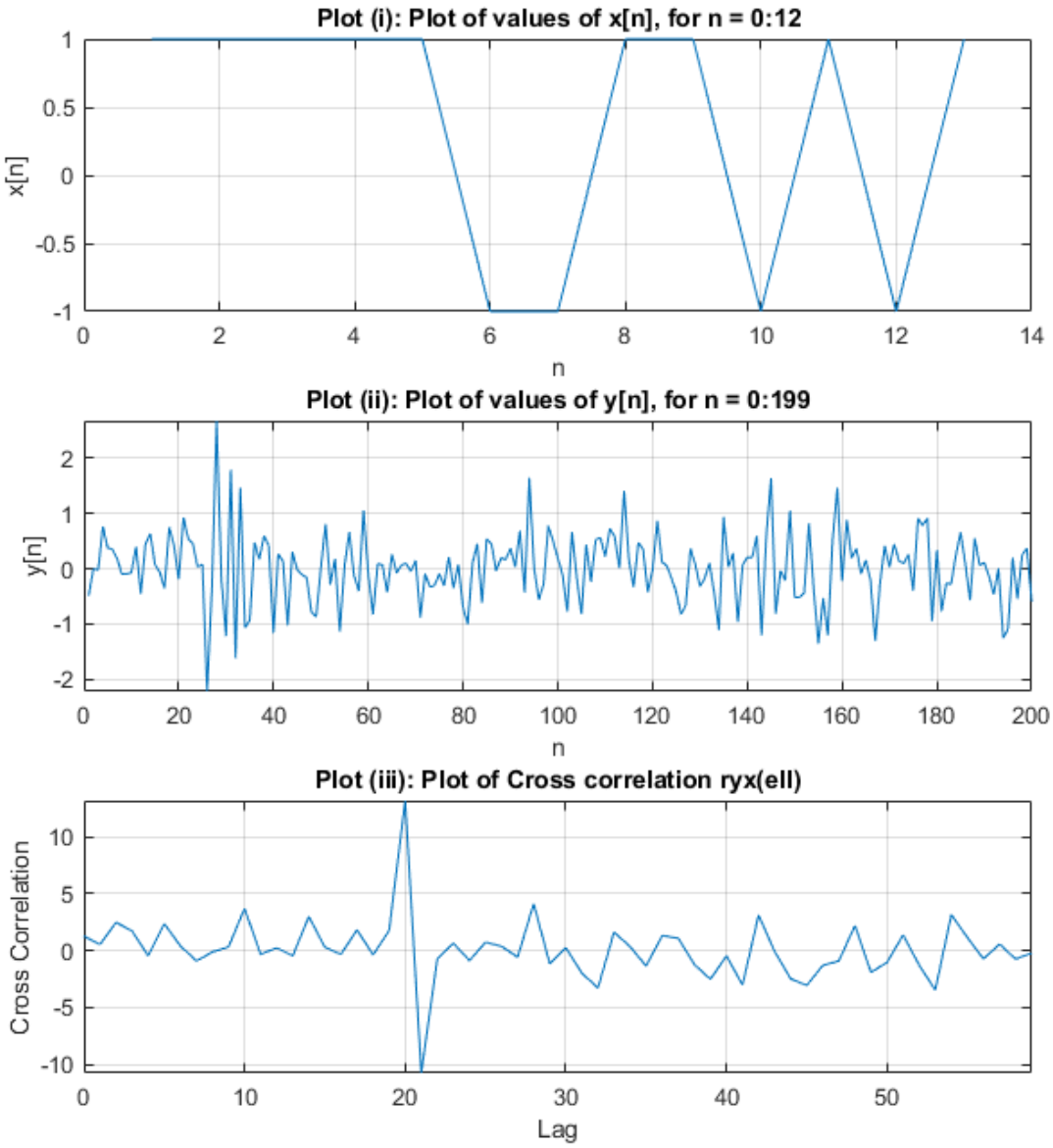
**Page 2: a2 = 1, D2 = 21, M = 13:**




Observations and explanations:

- Y[n] plot only has a single, relatively distinct crest at around n = 21, followed by a distinct trough.
- Approximately after N = 33, there shouldn't be a wave with significantly large amplitude, because the input x[n] only has 13 elements.
- Plot of cross correlation also only has a single distinct maximum at around delay = 20.

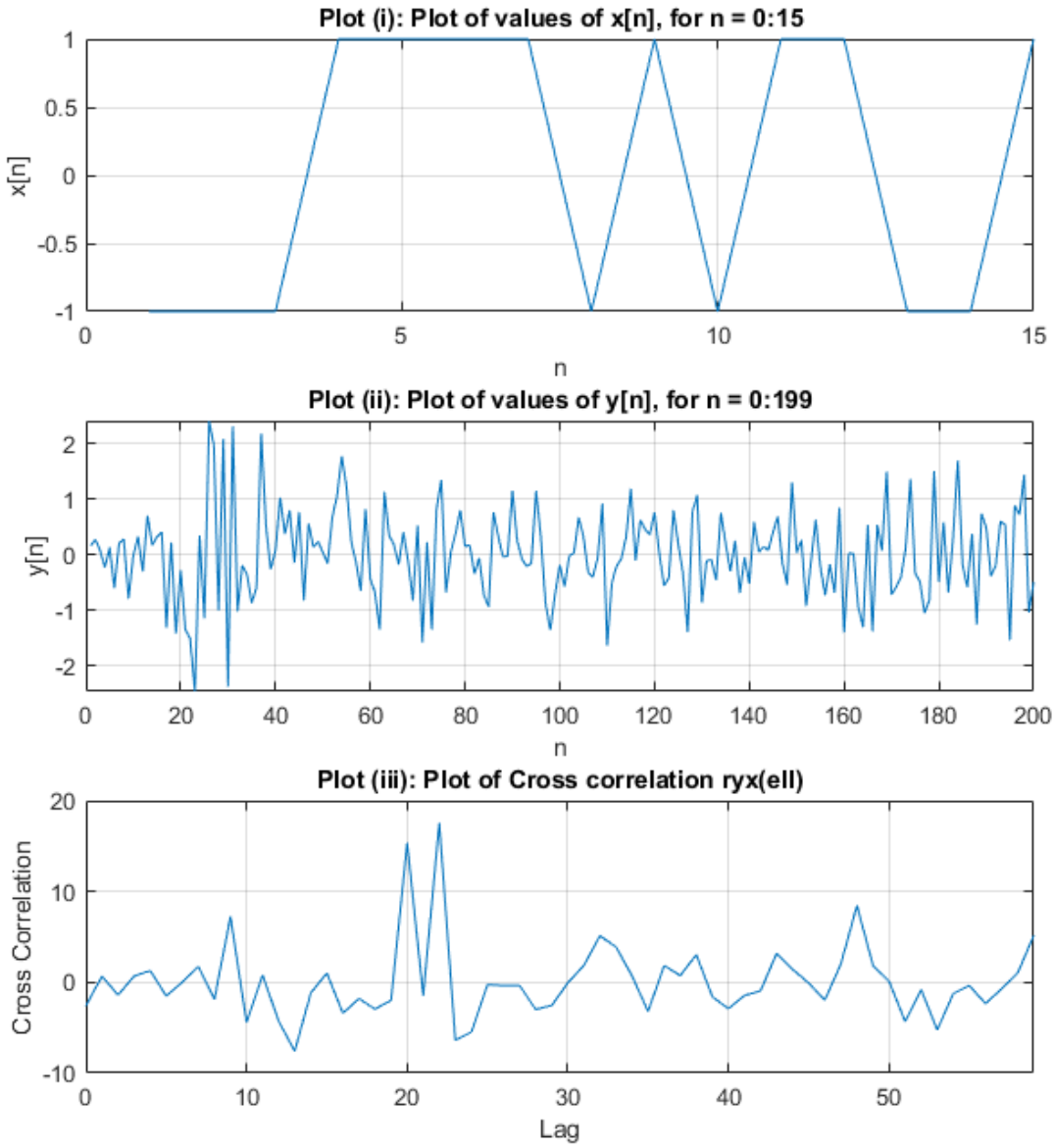
**Page 3: a2 = −1, D2 = 21, M = 13:**




Observation and explanation:

- Amplitude of y[n] at n = 21, compared to a2 = 1, is about only half
- Amplitude of y[n] hits maximum and minimum a lot while x[n] is inputted (N = 20~33).
- Cross correlation not only shows a distinct maximum at delay = 20, but also a distinct minimum at delay = 21.

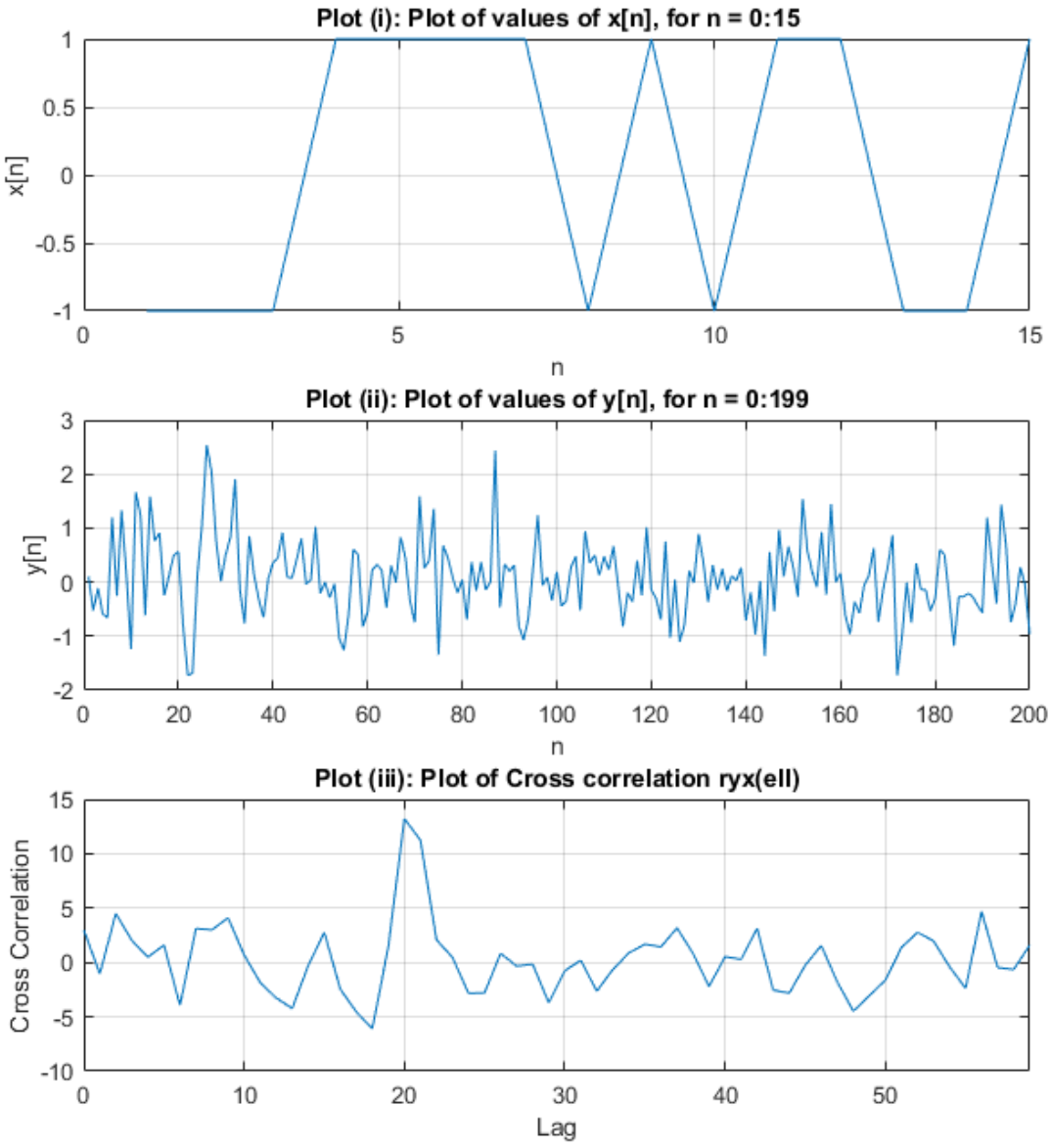
**Page 4: a2 = 1, D2 = 22, M = 15:**




Observations and explanation:

- Similar to M=13 sequence, most of the maximum and minimum amplitudes are around time period of n = 20 ~ 40.
- As compared to M=13 sequence plots, the y[n] start by hitting the trough first before hitting crest multiple times.
- The cross-correlation plot has two distinct maximum amplitudes at delay = 20 and 22, whereas D2 = 22 plot for M=13 only had one.

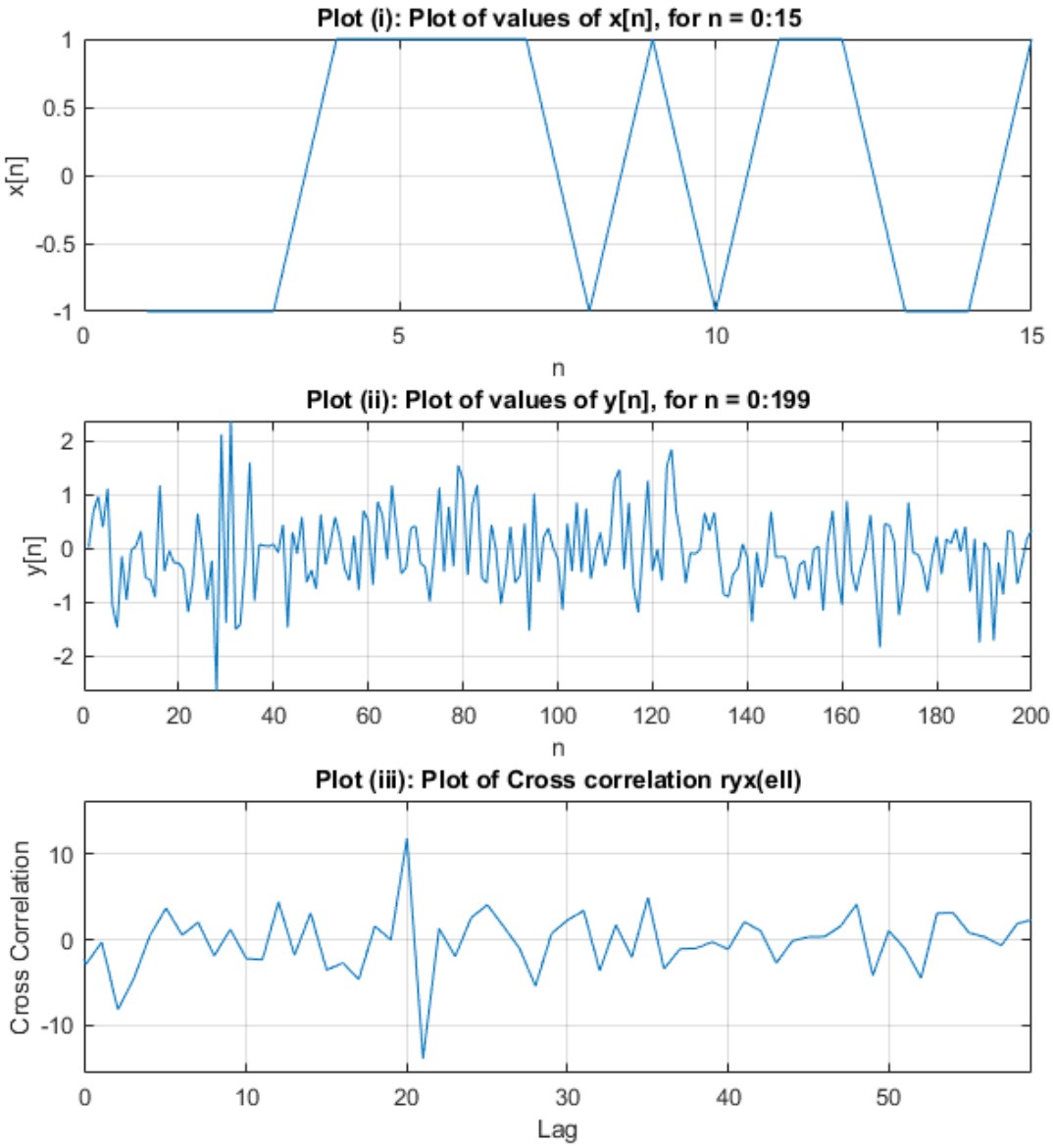
**Page 5: a2 = 1, D2 = 21, M = 15:**




Observations and explanations:

- y[n] plot is similar to that of D2 = 22, in a sense that both plots hits the minimum first before jumping to hit the maximum. However, this y[n] plot has lower frequency of fluctuation in the N = 20 ~ 40 period, compared to that of D2 = 22.
- Cross correlation plot only has one distinct maximum amplitude, at delay = 20, followed by a slight lower maximum at delay = 21.

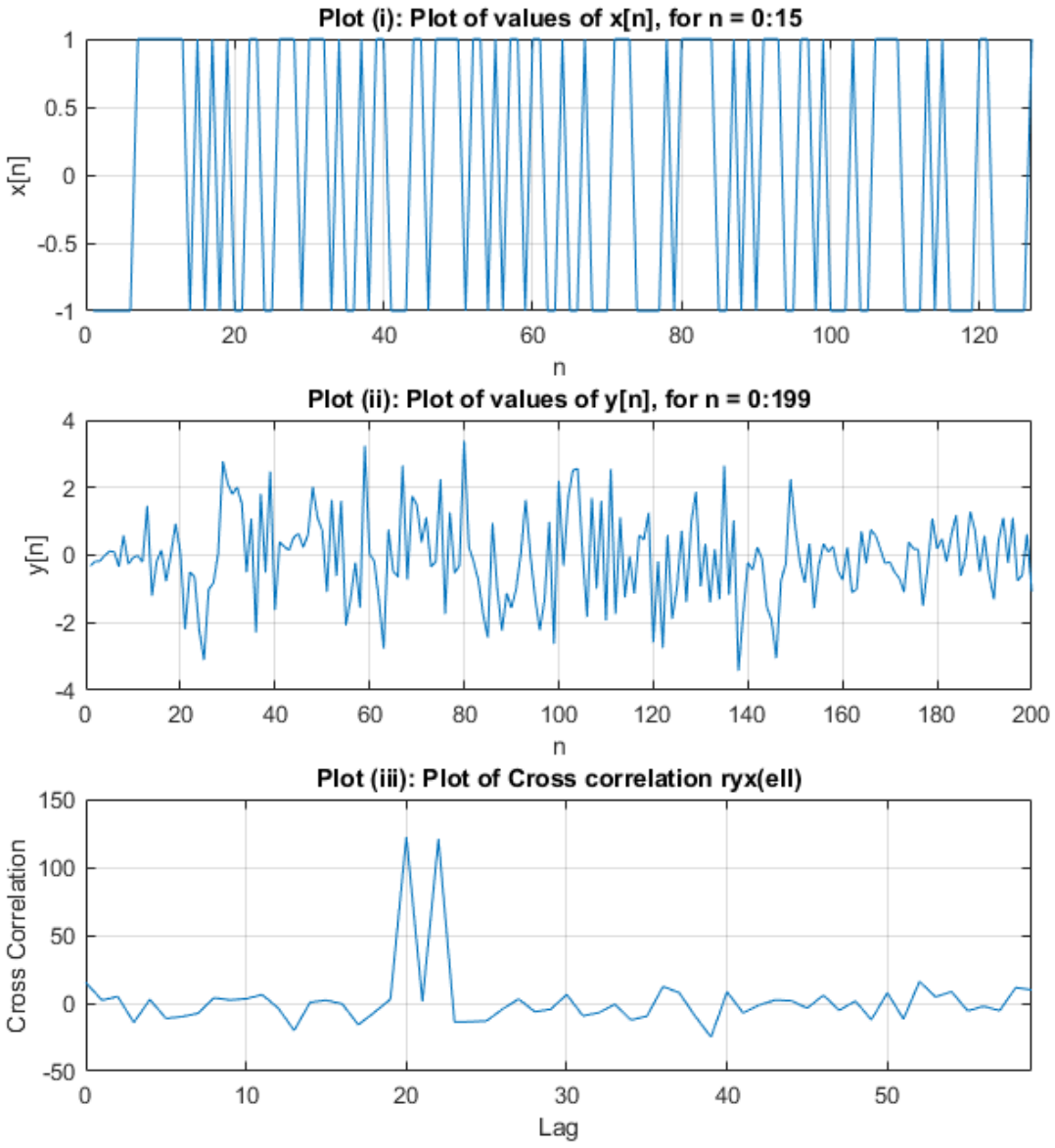
**Page 6: a2 = −1, D2 = 21, M = 15:**




Observations and explanations:

- The y[n] plot fluctuates and hits the maximum and minimum several times between n = 20 ~ 40. Afterwards, the plot stabilizes.
- The amplitude of y[n] at n = 21, as compared to a2 = 1, is only about half.
- The cross correlation plot has it's distinct maximum at delay = 20, followed by a distinct minimum at delay = 21.

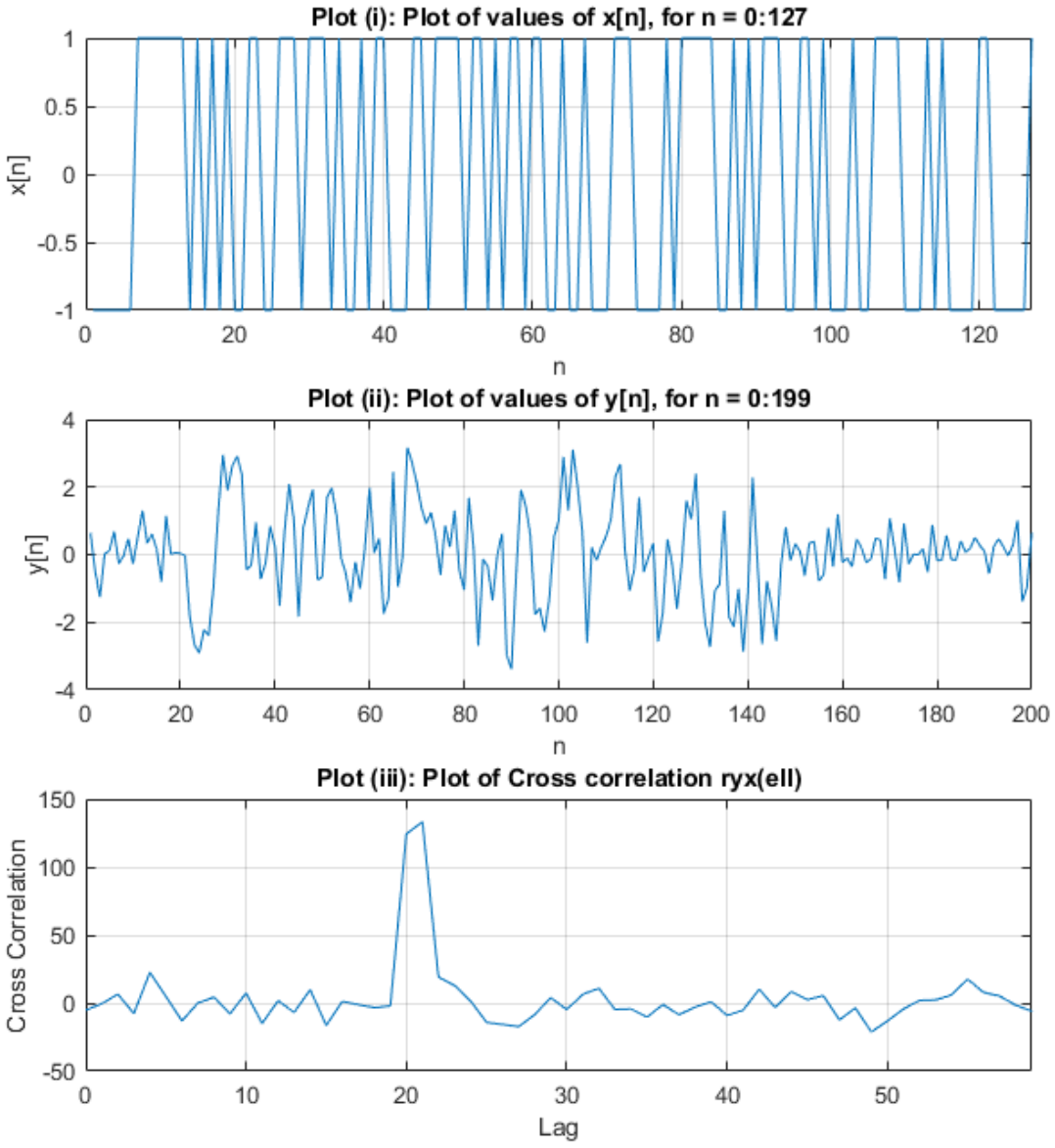
**Page 7: a2 = 1, D2 = 22, M = 127 :**




Observations and explanations:

- The plot of y[n] is very different from the previous plots with lower value of M that stabilizes around n = 40 and afterwards. Since x[n] with M = 127 has much longer input signal to y[n], a longer dynamic fluctuation is expected for a longer time.
- Y[n] plot seems to have multiple maximums and minimums between N = 20 ~ 150.
- Cross correlation plot was no different than the other plots above. The plot has two distinct maximum at delay = 20 and 22.

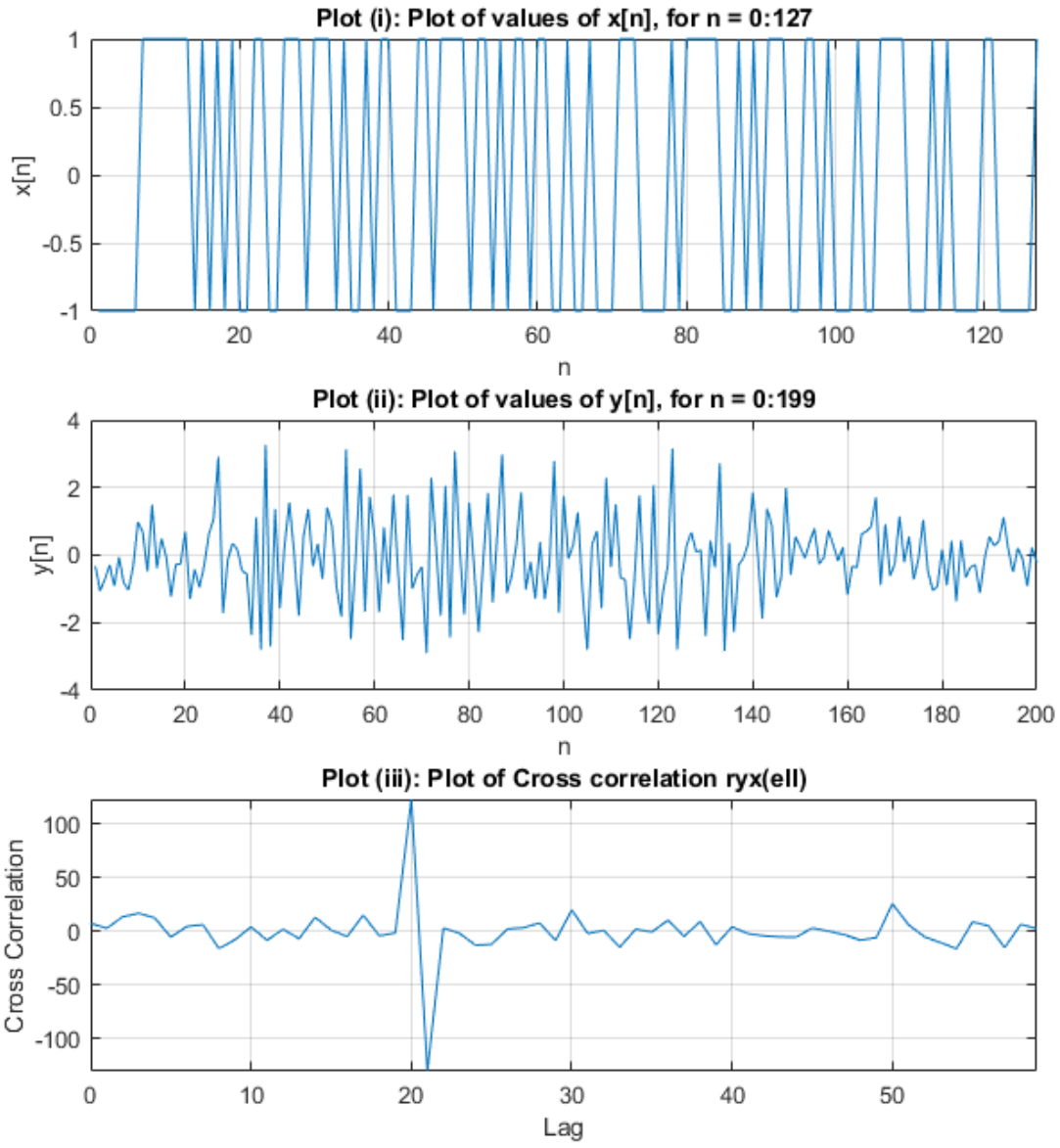
**Page 8: a2 = 1, D2 = 21, M = 127 :**




Observations and explanations:

- Plot of y[n] has shown far less frequencies of waves, as compared to the plot in the above page with D2 = 22.
- Given that x[n] signal has 127 elements, y[n] should theoretically stop making pulses after n = 149. The plot stabilizes after around n = 150, to waves with lower amplitudes.
- Cross correlation plot has a distinct maximum amplitude at delay = 20 and 21.

**Page 9: a2 = −1, D2 = 21, M = 127:**




Observations and explanations:

- Similar to the above two graphs, y[n] fluctuates dynamically starting from n=20. However, the amplitude at n = 21 is only about half of that with positive a2 value.
- The cross correlation plot shows a distinct maximum at delay = 20, followed by a distinct minimum at n = 21.

## Appendix A – MATLAB Source code for Page 1 ~ 3 (M = 13)

```
%-----------------------------%
%         Sean Hwang          %
% ECE 538 - MATLAB Homework 1 %
%     Source Code File        %
%-----------------------------%

% Parameters to be changed

a2 = 1;
D2 = 22;

x = [1 1 1 1 1 -1 -1 1 1 -1 1 -1 1 zeros(1,200-13)]; %For M=13
x20 = [zeros(1,20) 1 1 1 1 1 -1 -1 1 1 -1 1 -1 1 zeros(1, 200-13-20)];
%x[n-20]
xD2 = [zeros(1,D2) 1 1 1 1 1 -1 -1 1 1 -1 1 -1 1 zeros(1, 200-13-D2)];
%x[n-D]

% Parameters not to be changed

n = 0:199;
v = randn(1,200) * 1; %variance == std.div, since 1.

y = x20 + a2*xD2 + v; %y[n] = x[n-20] + a2x[n-D2] + v[n]
ryx = conv(y,x(end:-1:1));

%Plot generation

%Plot i
subplot(3,1,1);
xn = [1 1 1 1 1 -1 -1 1 1 -1 1 -1 1]; %For better viewing
plot (xn);
grid on;
xlabel('n');
ylabel('x[n]');
title('Plot of values of x[n], for n = 0:12');

%Plot ii
subplot(3,1,2);
plot (y);
grid on;
xlabel('n');
ylabel('y[n]');
title('Plot of values of y[n], for n = 0:199');

%plot iii
subplot(3,1,3);
plot (bound,ryx);
xlim([0 59]);
grid on;
xlabel ('Lag');
ylabel ('Cross Correlation');
title ('Plot of Cross correlation ryx(ell)');
```

## Appendix B – MATLAB Source code for Page 4 ~ 6 (M = 15)

```
%-----------------------------%
%         Sean Hwang          %
% ECE 538 - MATLAB Homework 1 %
%     Source Code File        %
%-----------------------------%

% Parameters to be changed

a2 = 1;
D2 = 22;

x = [-1 -1 -1 1 1 1 1 -1 1 -1 1 1 -1 -1 1 zeros(1,200-15)]; %For M=15
x20 = [zeros(1,20) -1 -1 -1 1 1 1 1 -1 1 -1 1 1 -1 -1 1 zeros(1, 200-15-
20)]; %x[n-20]
xD2 = [zeros(1,D2) -1 -1 -1 1 1 1 1 -1 1 -1 1 1 -1 -1 1 zeros(1, 200-15-
D2)];  %x[n-D]

% Parameters not to be changed

n = 0:199;
v = randn(1,200) * 1; %variance == std.div, since 1.

y = x20 + a2*xD2 + v; %y[n] = x[n-20] + a2x[n-D2] + v[n]
ryx = conv(y,x(end:-1:1));

%Plot generation

%Plot i
subplot(3,1,1);
xn = [-1 -1 -1 1 1 1 1 -1 1 -1 1 1 -1 -1 1]; %For better viewing
plot (xn);
grid on;
xlabel('n');
ylabel('x[n]');
title('Plot of values of x[n], for n = 0:15');

%Plot ii
subplot(3,1,2);
plot (y);
grid on;
xlabel('n');
ylabel('y[n]');
title('Plot of values of y[n], for n = 0:199');

%plot iii
subplot(3,1,3);
plot (bound,ryx);
xlim([0 59]);
grid on;
xlabel ('Lag');
ylabel ('Cross Correlation');
title ('Plot of Cross correlation ryx(ell)');
```

## Appendix C – MATLAB Source code for Page 7 ~ 9 (M = 127)

```
% Parameters to be changed
a2 = 1;
D2 = 22;

% Generating sequence for M=127 using given M=15 file
register=[1 0 0 0 0 0 0];
for ri=1:127,
m127(ri)=register(1,7);
register(2:7)=register(1:6);
register(1,1)=rem((register(1,1)+m127(1,ri)),2);
end
m127=2*m127-1;

x = [m127 zeros(1, 200-127)];
x20 = [zeros(1,20) m127 zeros(1, 200-127-20)];
%x[n-20]
xD2 = [zeros(1,D2) m127 zeros(1, 200-127-D2)];
%x[n-D]

% Parameters not to be changed
n = 0:199;
v = randn(1,200) * 1; %variance == std.div, since 1.
y = x20 + a2*xD2 + v; %y[n] = x[n-20] + a2x[n-D2] + v[n]
ryx = conv(y,x(end:-1:1));

%Plot generation

%Plot i
subplot(3,1,1);
plot (m127);
xlim([0 127]);
grid on;
xlabel('n');
ylabel('x[n]');
title('Plot (i): Plot of values of x[n], for n = 0:127');

%Plot ii
subplot(3,1,2);
plot (y);
grid on;
xlabel('n');
ylabel('y[n]');
title('Plot (ii): Plot of values of y[n], for n = 0:199');

%plot iii
subplot(3,1,3);
plot (bound,ryx);
xlim([0 59]);
grid on;
xlabel ('Lag');
ylabel ('Cross Correlation');
title ('Plot (iii): Plot of Cross correlation ryx(ell)');
```