ECE 311

Lab3 report

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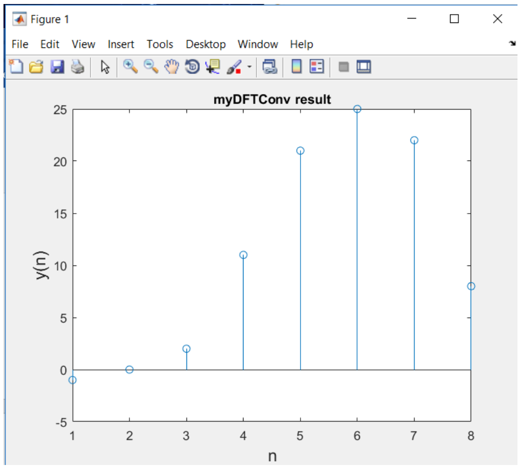
Report Item 1:

Code Part:

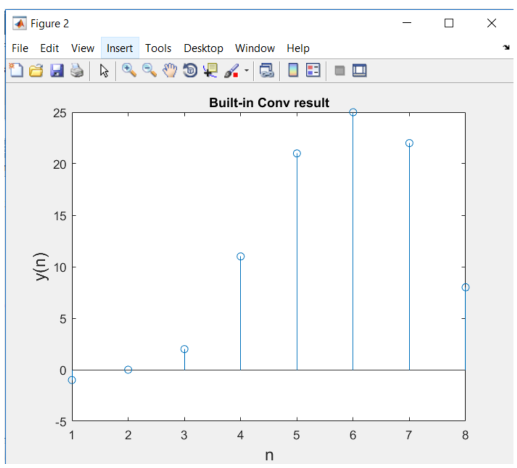
```
function [y] = myDFTConv(x, h)
M = length(x);
N = length(h);
y = zeros(1, M+N-1);

x_pad = [x zeros(1, N-1)];
h_pad = [h zeros(1, M-1)];

y = ifft(fft(x_pad).*fft(h_pad));

ans = conv(x, h);

figure(1);
stem(y);
xlabel('n','fontsize',14);
ylabel('y(n)','fontsize',14);
title('myDFTConv result');

figure(2);
stem(ans);
xlabel('n','fontsize',14);
ylabel('y(n)','fontsize',14);
title('Built-in Conv result');
end
```

Explanation:

The figure 1 below is the plot for the DFTConv of x = [-1, 2, 1, 5, 4] and h = [1, 2, 3, 2] using my own implemented function. And it contains the output using stem function.



The figure 2 below is the plot for the DFTConv of x = [-1, 2, 1, 5, 4] and h = [1, 2, 3, 2] using the build-in Conv function in the Matlab. And it contains the output using stem function.



Since these two plots are exactly the same, the result of my DFTConv function ought to be correct. Complexity of the fft will be: O(Nlog(N)) and the complexity of the ifft is O(Nlog(N)) also. Then the overall complexity is $O(N^2 \log^2(N))$

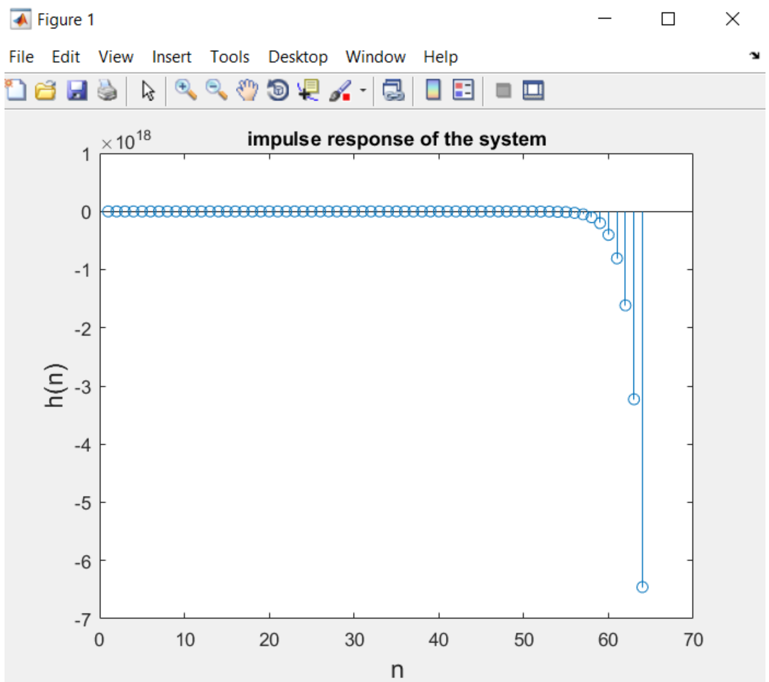
Report Item 2:

Code part:

```
function [y] = sys1(a, x)
%y{n} = 2*y(n-1) + 0.3x(n) - 2*x(n-10)
M = length(x);
y = zeros(1, M);
h = zeros(1, 64);
y(1, 1) = 0.3*x(1, 1);
if M > 1
    for i = 2 : M
        y(1, i) = a*y(1, i-1) + 0.3*x(1, i) - 2*x(1, i-1);
    end
end

h(1, 1) = 0.3;
for j = 2 : 64
    h(1, j) = a*h(1, j-1);
    if j == 2
        h(1, j) = h(1, j) - 2;
    end
end

figure(1);
stem(h);
xlabel('n','fontsize',14);
ylabel('h(n)','fontsize',14);
title('impulse response of the system');

end
```

Explanation part:

The figure 1 below is the plot of the impulse response h(n) using my own implemented function. And it contains the output using stem function with N = 64.



The system is not stable because the impulse response does not converge. And the system is causal because y[n] doesn't depend on any value whose index is larger than n.

Report Item 3:

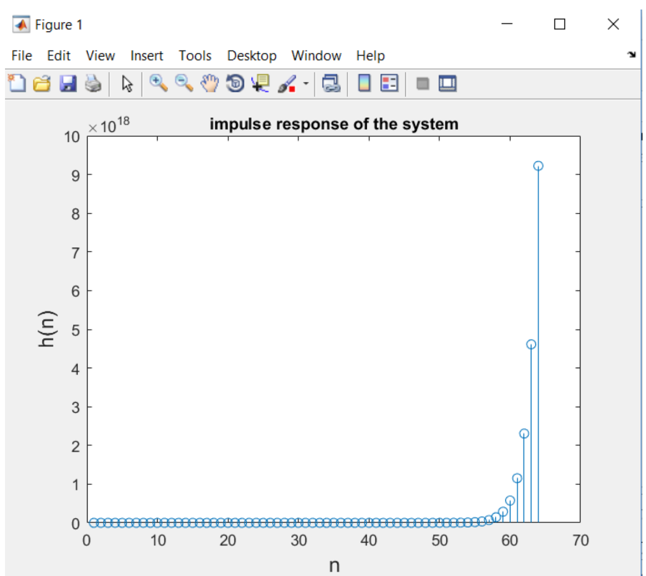
Code part:

```
function [y] = sys2(a, x)
%y{n} = a*y(n-1) + x(n)^2
M = length(x);
y = zeros(1, M);
h = zeros(1, 64);
y(1, 1) = x(1, 1)*x(1, 1);
if M > 1
    for i = 2 : M
        y(1, i) = a*y(1, i-1) + x(1, i)*x(1, i);
```

```
    end
end

h(1, 1) = 1;
for j = 2 : 64
    h(1, j) = a*h(1, j-1);
end

figure(1);
stem(h);
xlabel('n','fontsize',14);
ylabel('h(n)','fontsize',14);
title('impulse response of the system');

end
```

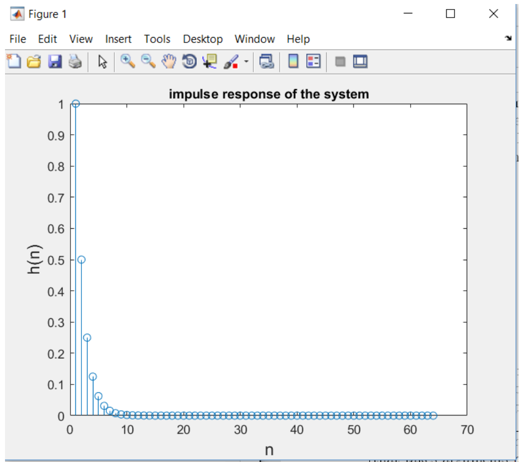
Explanation part:

The figure 1 below is the plot of the impulse response h(n) using my own implemented function. And it contains the output using stem function with N = 64 and a = 2.



The system is non-linear because $x(n)^2$ term. The system is causal because y[n] doesn't depend on any value whose index is larger than n. And the system is unstable because the impulse response does not converge. Since it is not a linear shift-invariance system, I can't find the output by convolving x(n) and h(n).

The figure 2 below is the plot of the impulse response h(n) using my own implemented function. And it contains the output using stem function with N = 64 and a = 0.5.



The system is non-linear because $x(n)^2$ term. The system is causal because y[n] doesn't depend on any value whose index is larger than n. And the system is stable because the impulse response does converge. Since it is not a linear shift-invariance system, I can't find the output by convolving x(n) and h(n).

Report Item 4:

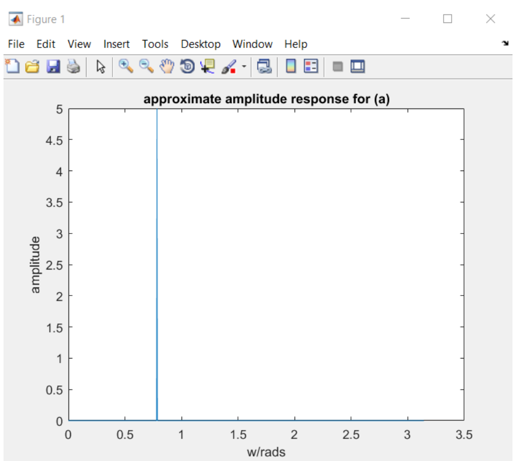
Code part:

```
%report item 4
w = linspace(0, pi, 1000);
amp1 = zeros(1, 1000);
amp2 = zeros(1, 1000);

for i = 1 : 1000
    if i == 1
        amp2(1, i) = 20;
    else
        if i == 250
            amp1(1, i) = 5;
        end
        if i < 1000/3
            amp2(1, i) = i;
        end
    end
end
```

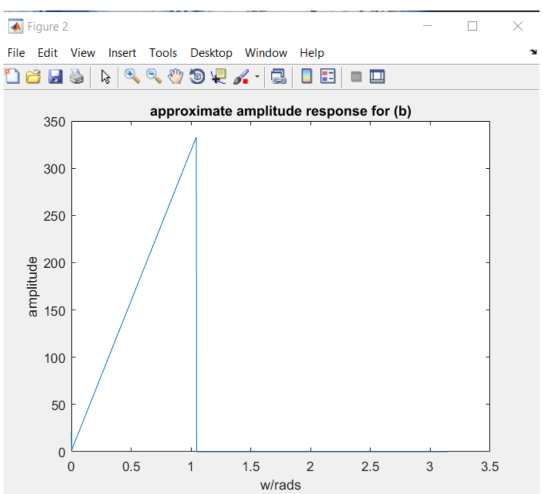
```
figure(1);
plot(w, amp1);
xlabel('w/rads');
ylabel('amplitude');
title('approximate amplitude response for (a)');

figure(2);
plot(w, amp2);
xlabel('w/rads');
ylabel('amplitude');
title('approximate amplitude response for (b)');
```

Explanation part:

The figure 1 below is the plot of the approximate magnitude response of (a)



The figure 2 below is the plot of the approximate magnitude response of (b)



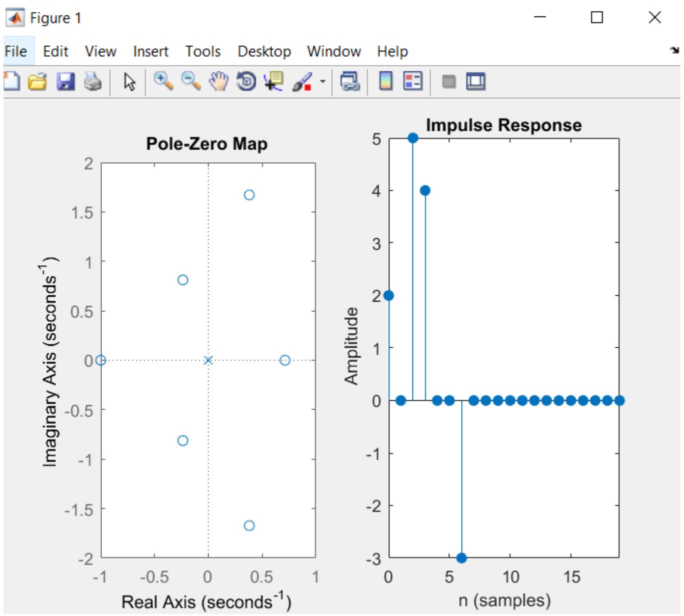
Report Item 5:

Code part:

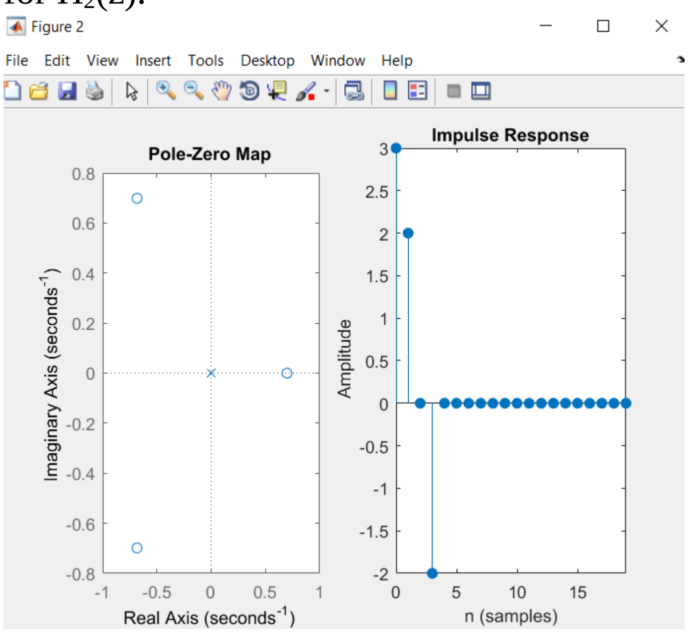
```
%report item 5
%H1(z) section
b1 = [2, 0, 5, 4, 0, 0, -3];
a1 = [1, 0, 0, 0, 0, 0, 0];
S1 = tf(b1, a1);
N = 20;

figure(1);
subplot(121);
pzplot(S1);
subplot(122);
impz(b1, a1, N);

%H2(z) section
b2 = [3, 2, 0, -2];
a2 = [1, 0, 0, 0];
S2 = tf(b2, a2);

figure(2);
subplot(121);
pzplot(S2);
subplot(122);
impz(b2, a2, N);

%H3(z) section
b3 = [0, 0, 0, 1, 0, 0, 1, -2];
a3 = [12, 1, 0, 4, 0, 0, 0, 0];
S3 = tf(b3, a3);

figure(3);
subplot(121);
pzplot(S3);
subplot(122);
impz(b3, a3, N);
```

Explanation part:

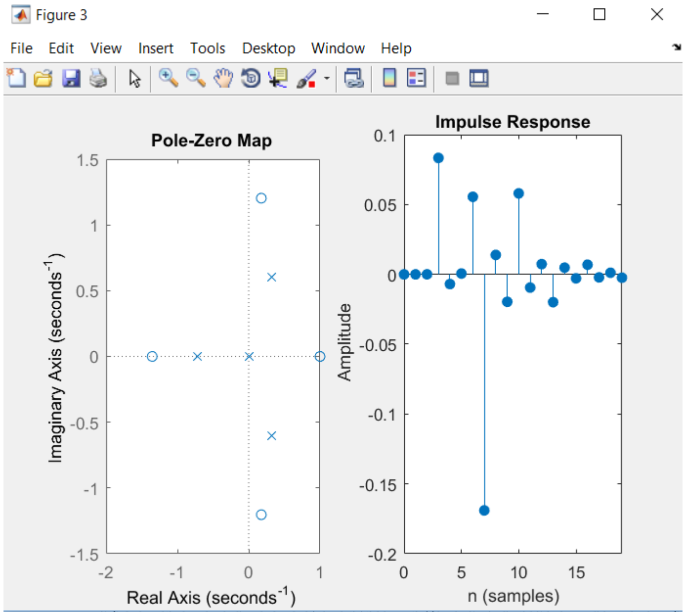
The figure 1 below is the plot of the pole-zero plot and impulse response of N = 20 for $H_1(z)$.



The figure 2 below is the plot of the pole-zero plot and impulse response of N = 20 for $H_2(z)$.



The figure 3 below is the plot of the pole-zero plot and impulse response of N = 20 for $H_3(z)$.



H_1 and H_2 are stable. H_3 is unstable because there is a pole on the right side of the s plane.

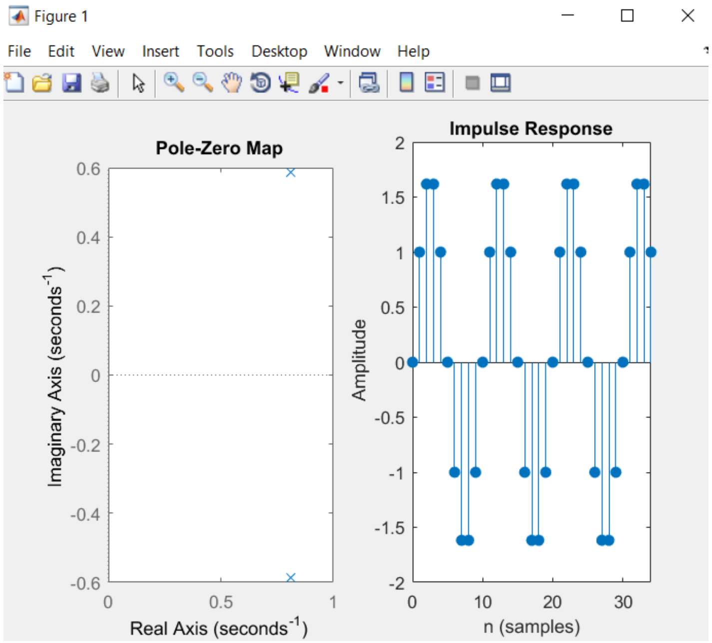
Report Item 6:

Code part:

```
%report_item 6
b = [0, 1];
a = [1, exp(-1i*8*pi/10)+exp(1i*8*pi/10), 1];
s = tf(b, a);
N = 35;
figure(1);
subplot(121);
pzplot(s);
subplot(122);
impz(b, a, N);
```

Explanation part:

The figure 1 below is the plot of the pole-zero plot and impulse response of N = 35 for H(z).



The system is not BIBO stable because there are poles on the right side of the plane.

The system will be unable when the input frequency $\omega = (2k+1)\pi + 4*\pi/5$ or $(2k+1)\pi - 4*\pi/5$. Otherwise, the system will be stable.