ECE 311 Lab 3

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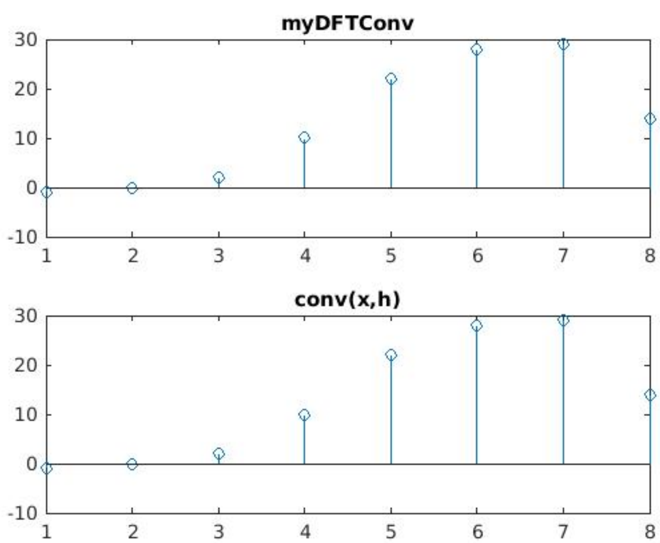
Report Item 1

```
function [ y ] = myDFTConv( x, h )

%transfer over to frequency domain
l = size(x,2) + size(h,2) - 1;
x_w = fft(x,l);
h_w = fft(h,l);

%element multiplication to get y_w
y_w = x_w.*h_w;

%return to discrete domain
y = ifft(y_w);

%plot my result
figure;
subplot(211);
stem(y);
title('myDFTConv');

%plot key
subplot(212);
stem(conv(x,h));
title('conv(x,h)');


end
```

myDFTConv.m

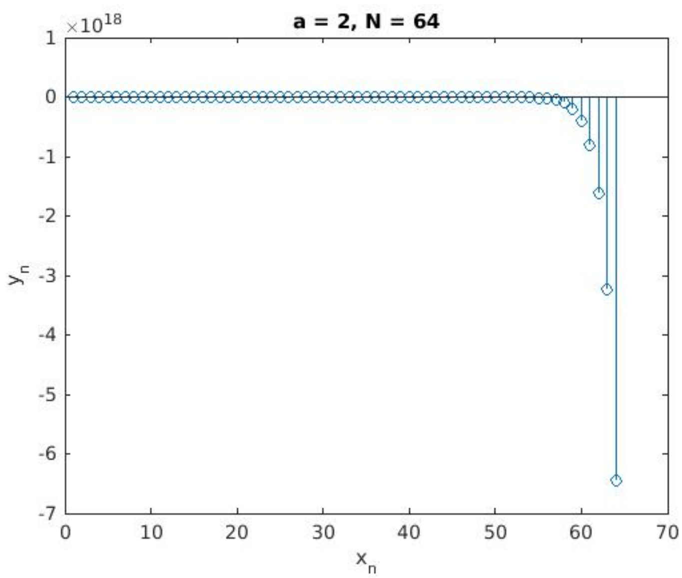


Because of the use of fft and ifft, the time coplexity is also $O(Nlog(N))$.

Report Item 2

```
function [ y_n ] = sys1( a,N )

%get delta function
x_n = zeros(1,N);
x_n(1) = 1;

%get shifted delta function
x_n_1 = zeros(1,N);
x_n_1(2) = 1;

y_n = zeros(1,N+1);

for i = 1:N,
    y_n(i+1) = a.*y_n(i) + 0.3.*x_n(i) -2.*x_n_1(i);
end
y_n = y_n(2:length(y_n)); % remove first element to get to N
figure;
stem(y_n);
title('a = 2, N = 64');
ylabel('y_n');
xlabel('x_n');
end
```

sys1.m

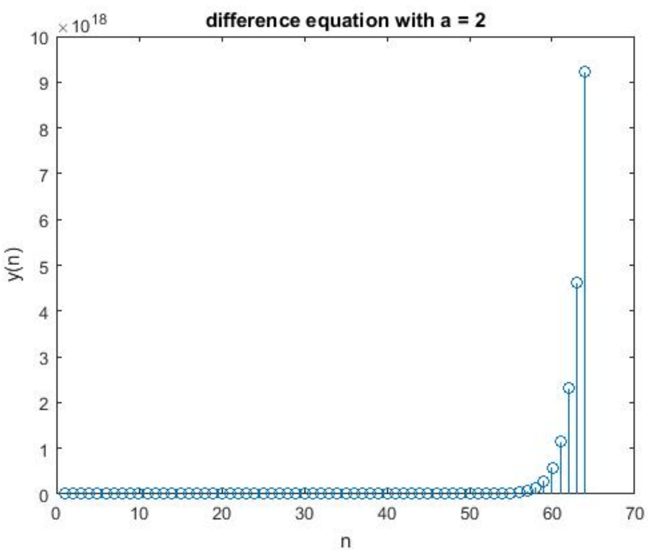


Notice that this function is in the order of $-e^x$ therefore, it is not stable $\lim_{x_n \to \infty} y_n = -\infty$. The system is causal, however, by the finite difference equation, output only depends on past or current inputs.

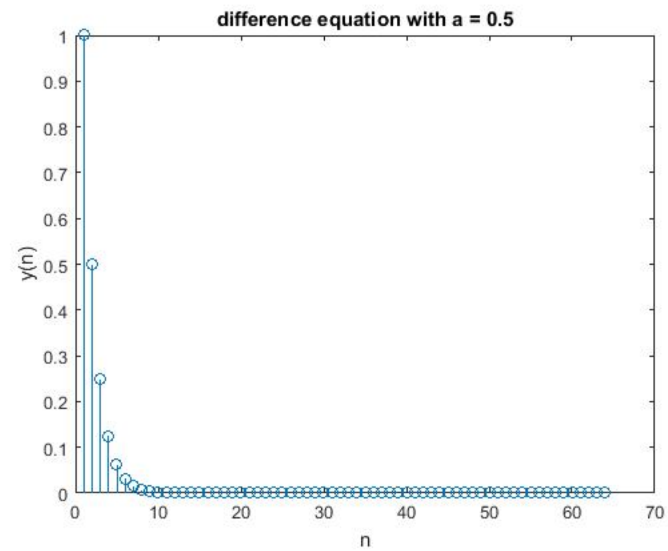
Report Item 3

```matlab
function [ y_n ] = sys2( x_n , a )
N = 64; % length always 64
y_n = zeros(1,N+1);

for i = 1:64,
    y_n(i+1) = a*y_n(i) + x_n(i).^2;
end
    y_n = y_n(2:length(y_n)); % remove first element to shorten to 64

    figure;
    stem(y_n);
    title('difference equation with a = 2');
    xlabel('n');
    ylabel('y(n)');
end
```

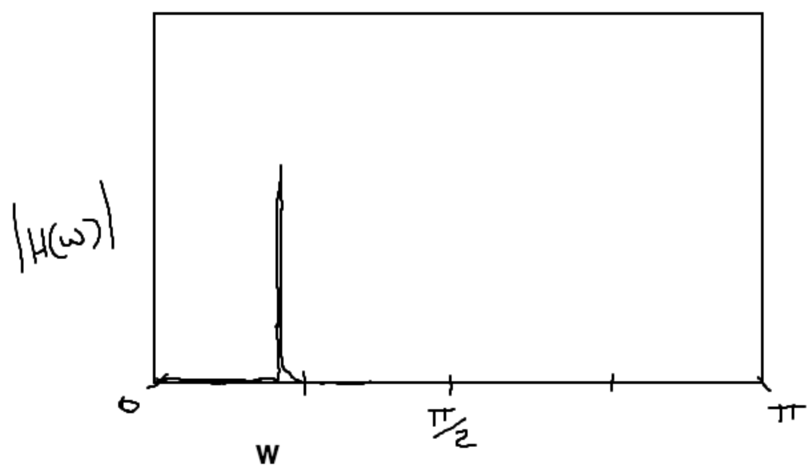
sys2.m



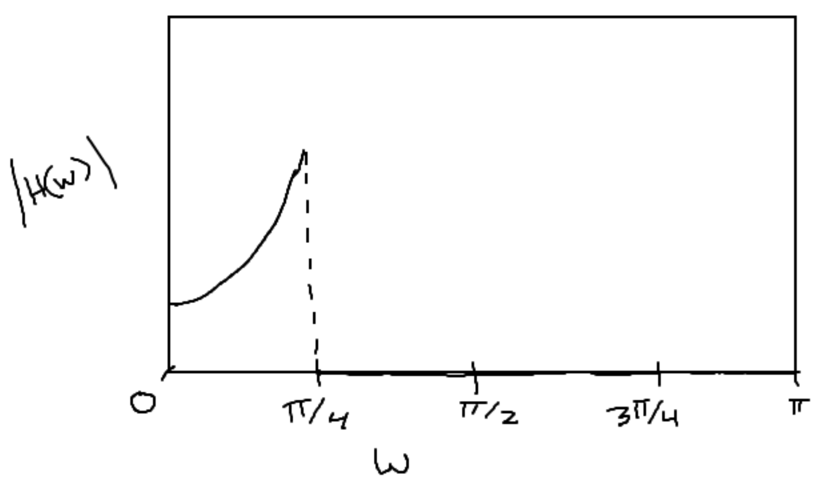
With $a = 2$ and $x(n) = (1, 0, 0, ...)$, or the delta function, we can see that the equation is not linear because of $x(n)^2$. The system is causal because of the fact that the finite difference equation output only depends on past or current inputs. Because the output graph is in the form of e^x, the equation is unstable.



With $a = 0.5$, the equation is not linear, causal, and is stable because $\lim_{x_n \to \infty} y_n = 0$.
(can you find the output to either system by convolving x(n) with h(n)?)



Report Item 4
We can see on the interval from $\omega = 0$ to π, that there is only one point where the magnitude is not zero. Therefore, there is a spike at that point.

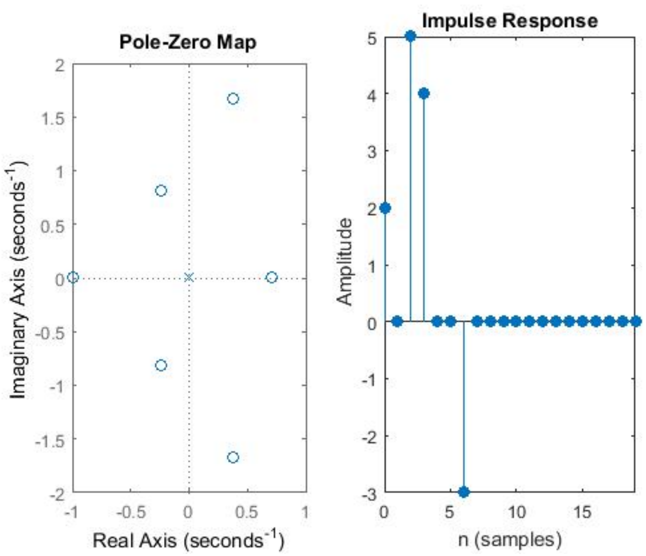


We can see on the interval from $\omega = 0 to \pi$ that there is a minimum at $\omega = 0$ and a maximum at $\omega = \pi/4$ so the graph is increasing until that point.

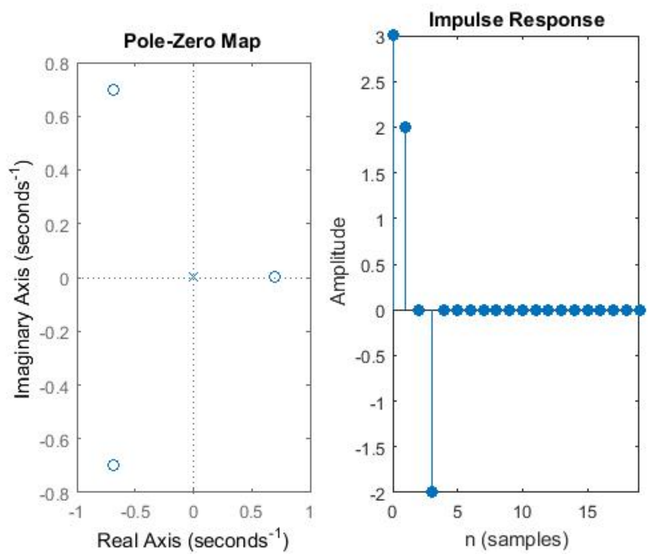
Report Item 5

```
function [  ] = pzplot_impz( a,b )
S = tf(b,a);
N = 20;

figure;
subplot(121);
pzplot(S);
subplot(122);
impz(b,a,N);
end
```

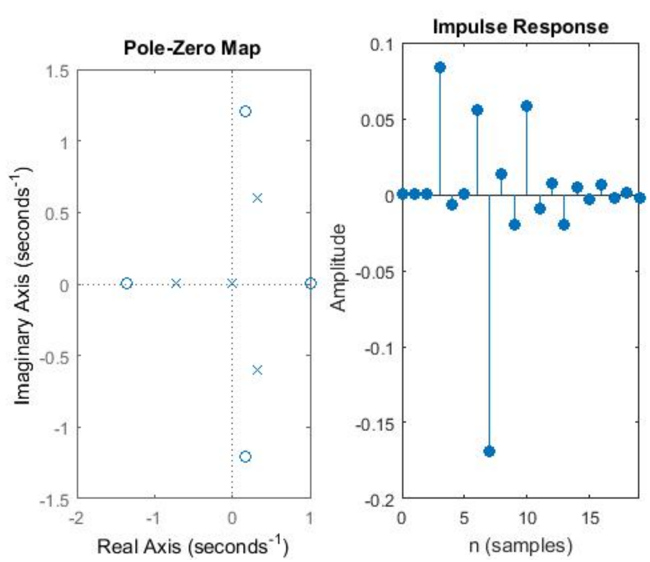
pzplot_impz.m



With $a = [1, 0, 0, 0, 0, 0, 0]$ and $b = [2, 0, 5, 4, 0, 0, -3]$ There are no poles on the unit circle so the system is stable.



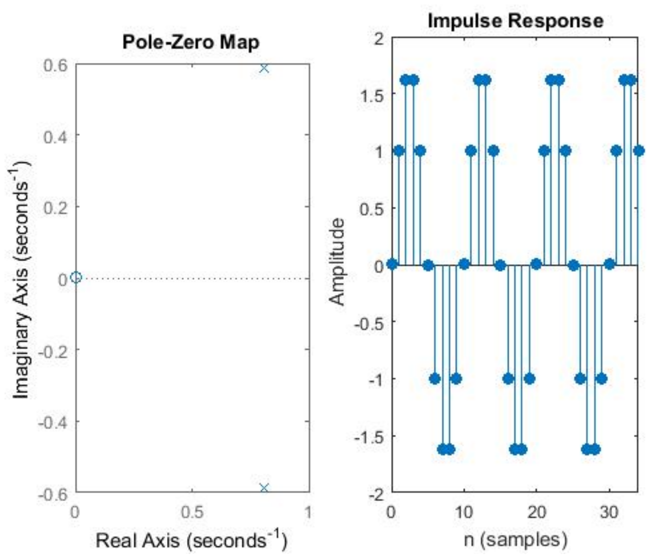
With $a = [1, 0, 0, 0]$ and $b = [3, 2, 0, -3]$, there are no poles outside the unit circle. Therefore, the system is stable.



With $a = [12, 1, 0, 4, 0, 0, 0, 0]$ and $b = [0, 0, 0, 1, 0, 0, 1, -2]$, there are no poles outside the unit circle. Therefore, the system is stable.

Report Item 6

$H(z) = \frac{z}{(z+e^{\frac{-i8\pi}{10}})(z+e^{\frac{i8\pi}{10}})}$
$= \frac{z}{z^2+ze^{\frac{-i8\pi}{10}}+ze^{\frac{i8\pi}{10}}+1}$
$= \frac{z}{z^2+2zcos(4\pi/5)+1}$
$= \frac{z^{-1}}{1+z^{-1}2cos(4\pi/5)+z^{-2}}$



$a = [1, 2cos(4\pi/5), 1], b = [0, 1, 0]$

The system is not BIBO stable, if we have a bounded input $z = -e^{\frac{+-i8\pi}{10}}$ then the output approaches infinity so the system is not BIBO stable. The system is stable when $|z| > e^{\frac{i8\pi}{10}}$ and unstable when $|z| \leq e^{\frac{i8\pi}{10}}$.