Bangladesh University of Engineering & Technology

Department of Electrical and Electronics Engineering

Lab Report

Experiment Name:

3. Z Transform and Its Applications

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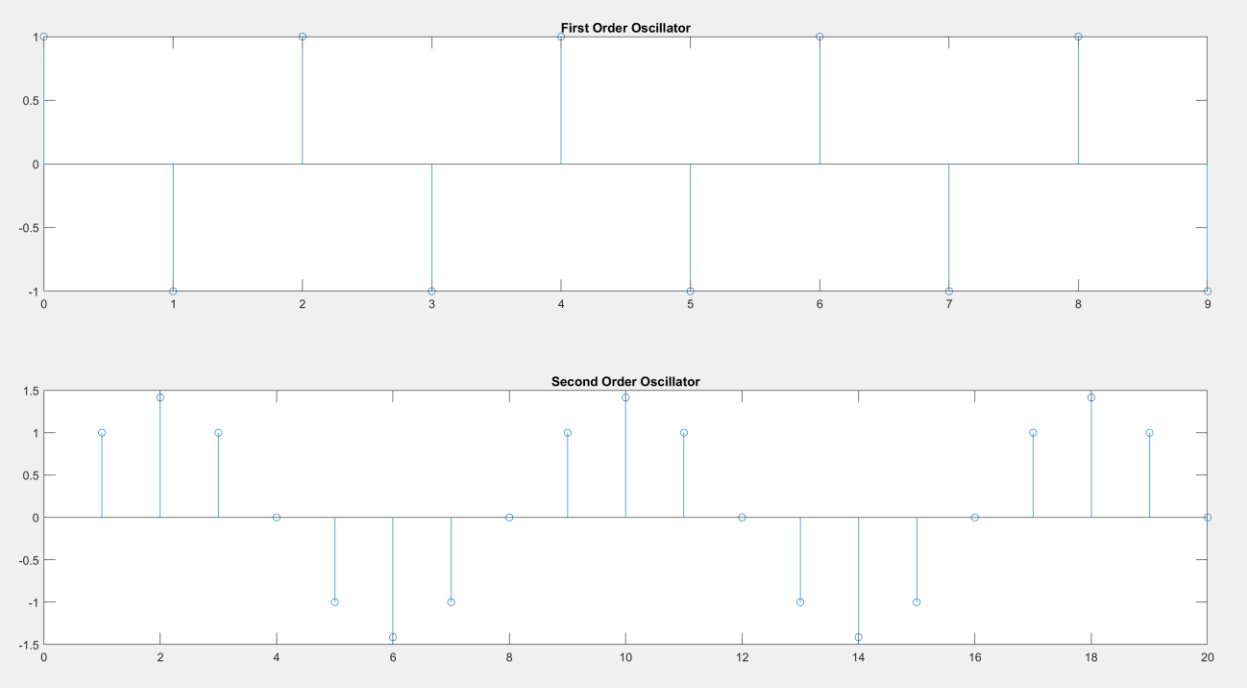
C1:

Code:

```
clc;
clearvars;

d1 = -1;
num = [1 0 0];
den1 = [1 -d1];
[h,t] = impz(num, den1);
subplot(2,1,1);
stem(t,h); title('First Order Oscillator')
d1 = 2^(-.5) + 2^(-.5)*1i;
d2 = conj(d1);

den2 = conv([1 -d1], [1 -d2]);
[h, t] = impz (num, den2, 20);
subplot(2,1,2);
stem(h); title('Second Order Oscillator');
```

Output:

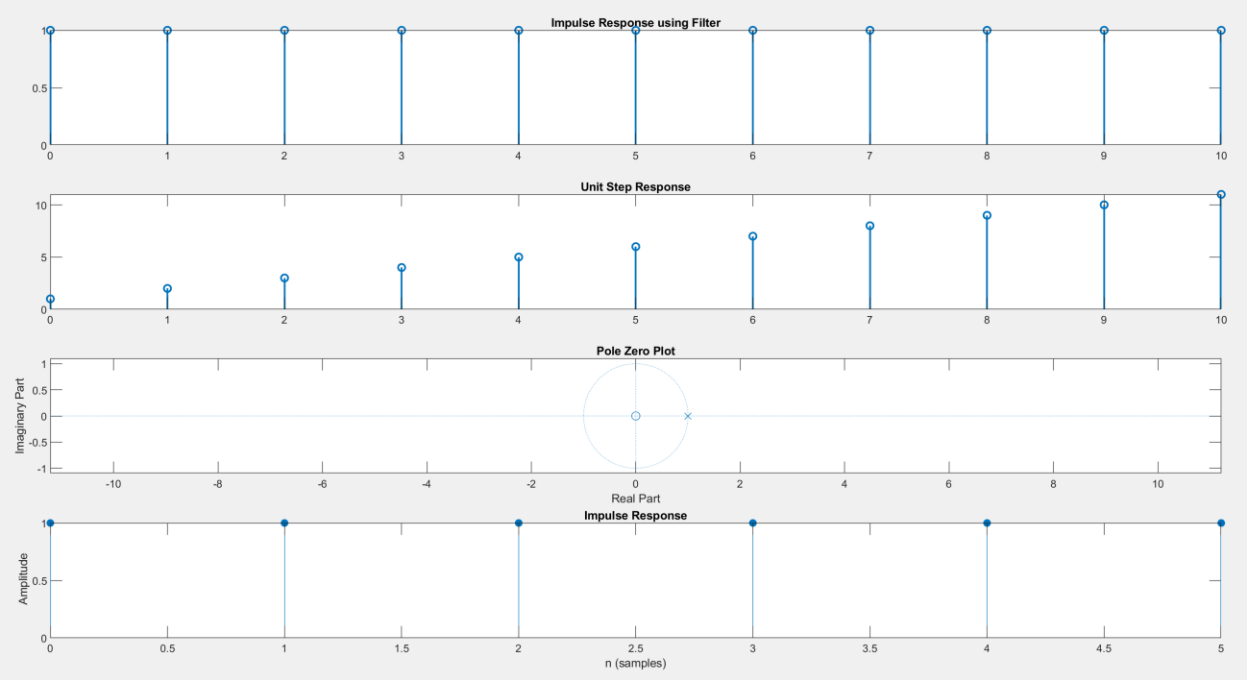


C3:

Code:

```
clc;
clearvars;

t = 0: 0.5 : 5;
a = [1 -1];
b = [1];

n = 0:10;
x1 = (n==0);
x2 = (n>=0);

y1 = filter(b,a,x1);
y2 = filter(b,a,x2);

subplot(4,1,1);
stem(n,y1, "Linewidth",1.5); title('Impulse Response
using Filter')
subplot(4,1,2);
stem(n,y2, "Linewidth",1.5); title('Unit Step
Response');
subplot(4,1,3);
zplane(b,a); title('Pole Zero Plot')
subplot(4,1,4);
impz(b,a,t);
```

Output:



Comment:

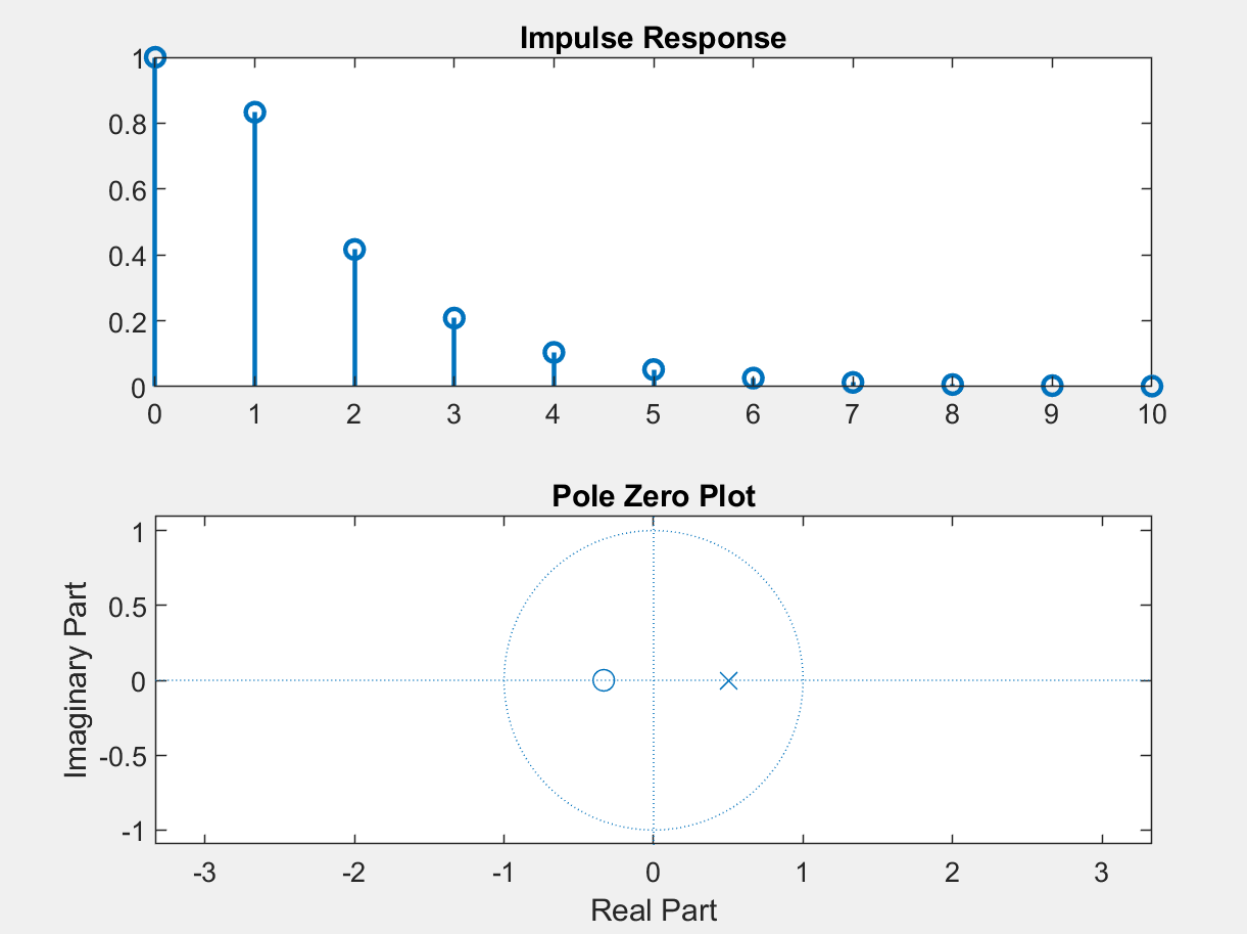
As the pole is on the unit circle, the ROC won't cover the unit circle which is why the system will be unstable.

C4:

Code:

```
clc;
clearvars;

a = [ 1 -.5];
b = [ 1 1/3];

n = 0:10;
x1 = (n==0); %unit response
y1 = filter(b,a,x1);

subplot(2,1,1);
stem(n,y1, "Linewidth",1.5); title('Impulse Response');
subplot(2,1,2);
zplane(b,a); title('Pole Zero Plot')
```

Output:



Comment:

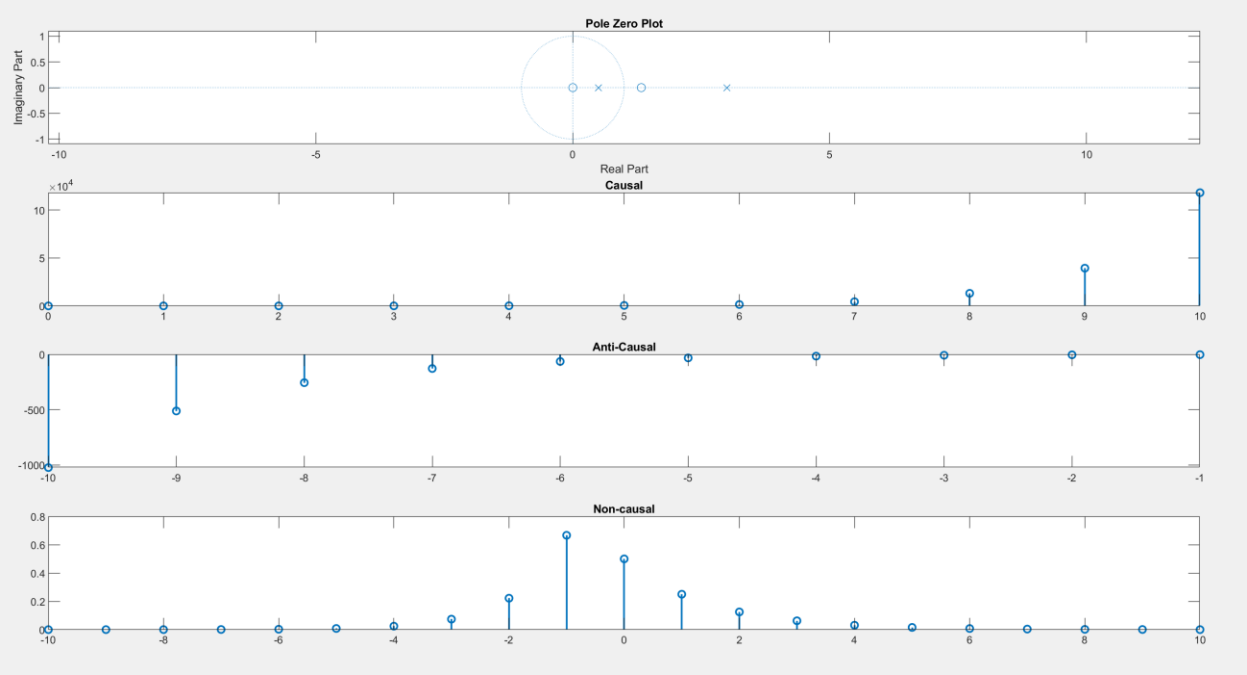
For causal stable LTI system, $|z| > 0.5$ as the pole is at 0.5 as the ROC is always exterior in this case.

C5:

Code:

```
clc;
clearvars;


num = [3 -4];
den = [ 1 -3.5 1.5];

subplot(4,1,1);
zplane(num, den); title('Pole Zero Plot')
[r,p,c] = residuez(num,den);
n = 0:10;
h1 = (r(1)*(p(1).^n) - r(2)*(p(2).^n));
subplot(4,1,2);
stem(n,h1, "Linewidth",1.5); title('Causal');

n = -10:-1;
h2 = (-r(1)*(p(1).^n))  -  (r(2)*(p(2).^n));
subplot(4,1,3);
stem(n,h2, "Linewidth",1.5); title('Anti-Causal')

a = 1:10;
b = -10:-1;
h3 = r(2)*p(2).^a;
h4 = r(1)*p(1).^b;
h = zeros(1,21);
h(11:20) = h3;
h(1:10) = h4;
subplot(4,1,4);
n = -10:10;
stem(n, h, "Linewidth",1.5); title ('Non-causal')
```

Output:



Comments:

The ROC regions are as follows:

1. |z| > 3 is for Causal System
2. |z| < 0.5 is for Anti-Causal System;
3. 0.5< |z| <3 is for Non-causal System;

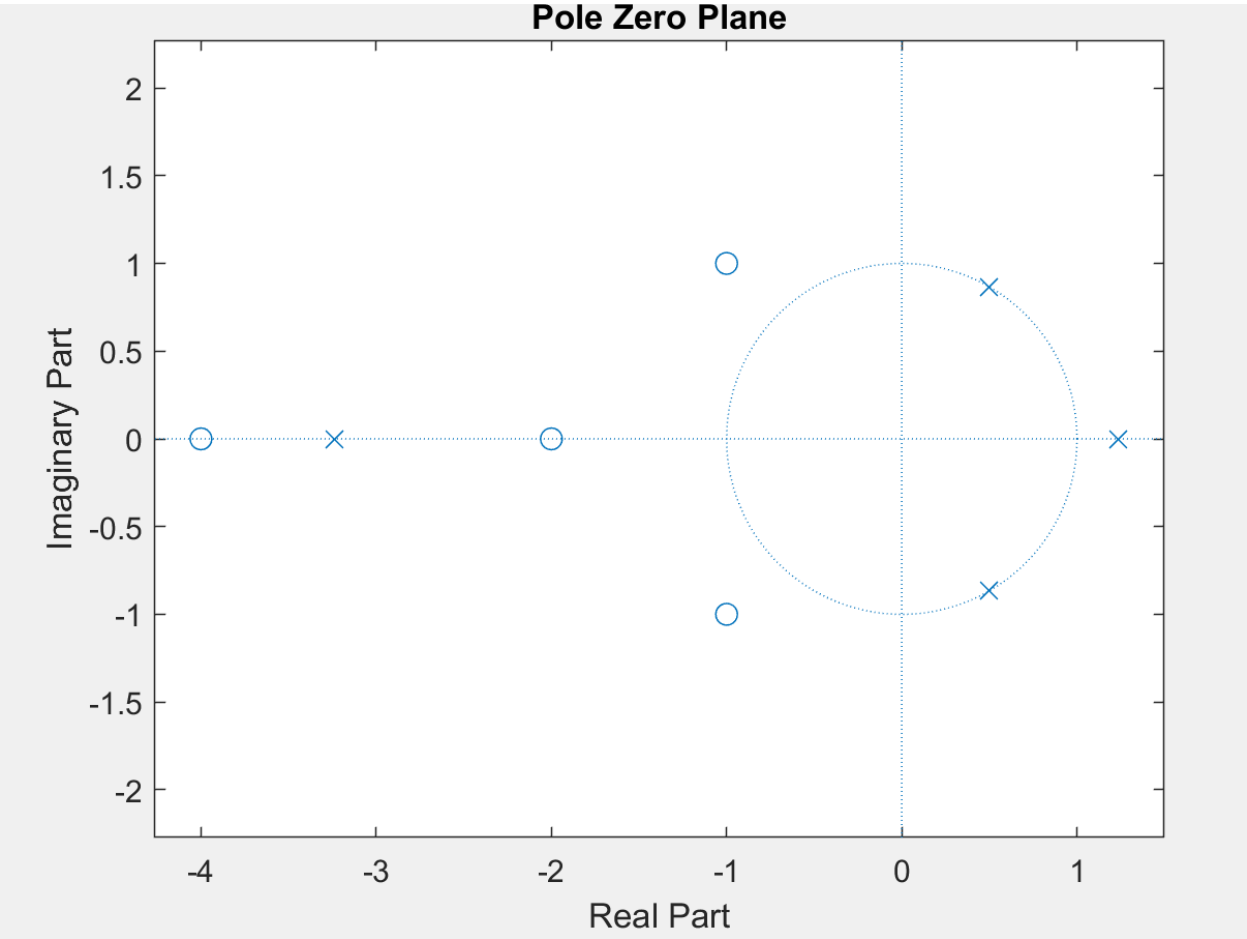
C6:

Code:

```
clc;
clearvars;

num = input("enter numerator coeff");
den = input("enter denominator coeff")

[r, p, c] = residuez(num,den);
zplane(num, den); title('Pole Zero Plane');

disp('Residues ='); disp(r);
disp('Poles ='); disp(p);
disp('Constant Direct Terms ='); disp(c);
```

Ooutput:

```
Residues =
  -0.0177 + 0.0000i
   9.4914 + 0.0000i
  -3.0702 + 2.3398i
  -3.0702 - 2.3398i

Poles =
  -3.2361 + 0.0000i
   1.2361 + 0.0000i
   0.5000 + 0.8660i
   0.5000 - 0.8660i

Constant Direct Terms =
   -2.6667
```



Comments:

The ROC are as follows:

Causal: |z| > 3.236

Anti-Causal: |z| < 1

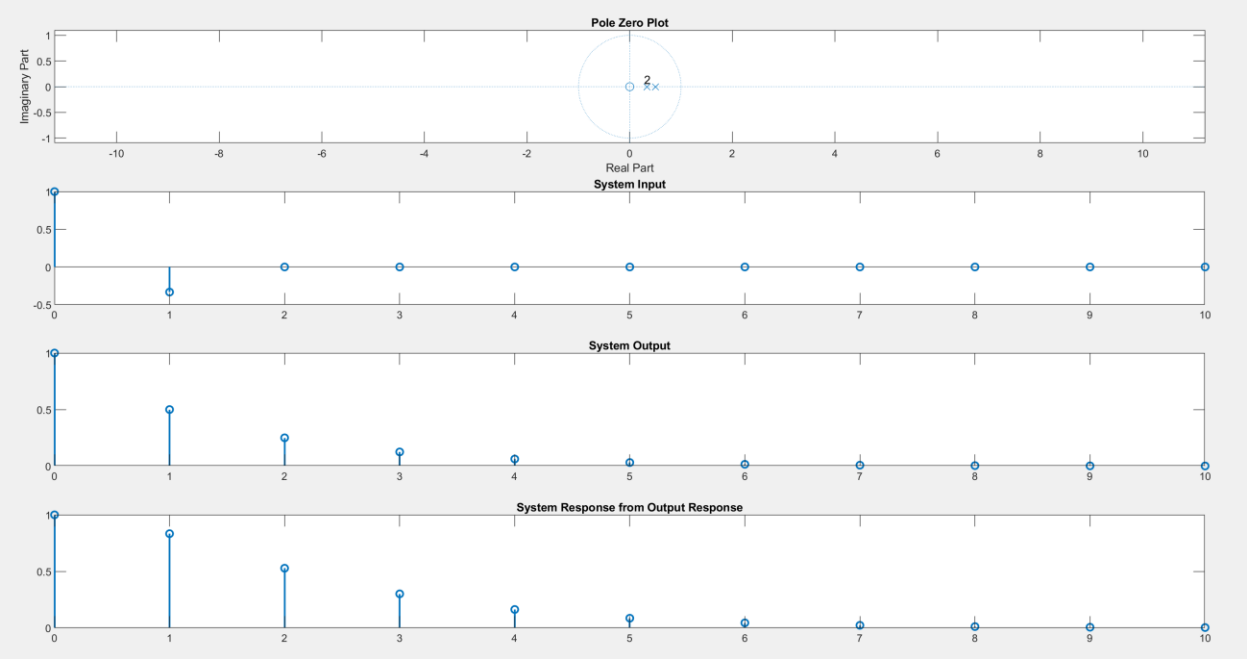
Non-Causal: 1 < |z| < 1.236 or 1.236< |z|< 3.236

C7:

Code:

```
clc;
clearvars;
%c7
a = [1 -5/6 1/6];
b = [1];

subplot(4,1,1);
zplane(b,a); title('Pole Zero Plot')
n = 0:10;
x1 = [1 -1/3 0 0 0 0 0 0 0 0 0];
y1 = filter(b,a,x1);
subplot(4,1,2);
stem(n,x1, "Linewidth",1.5); title('System Input');
subplot(4,1,3);
stem(n,y1, "Linewidth",1.5); title('System Output');

imp = zeros(1, length(n));
imp(1) = y1(1);
for i = 2:length(n)
    imp(i) = y1(i) + 1/3 * imp(i-1); %iterative
approach
end

subplot(4,1,4)
stem(n,imp, "Linewidth",1.5); title('System Response
from Output Response');
```

Output:


Pole Zero Plot
Imaginary Part
Real Part
2
System Input
System Output
System Response from Output Response

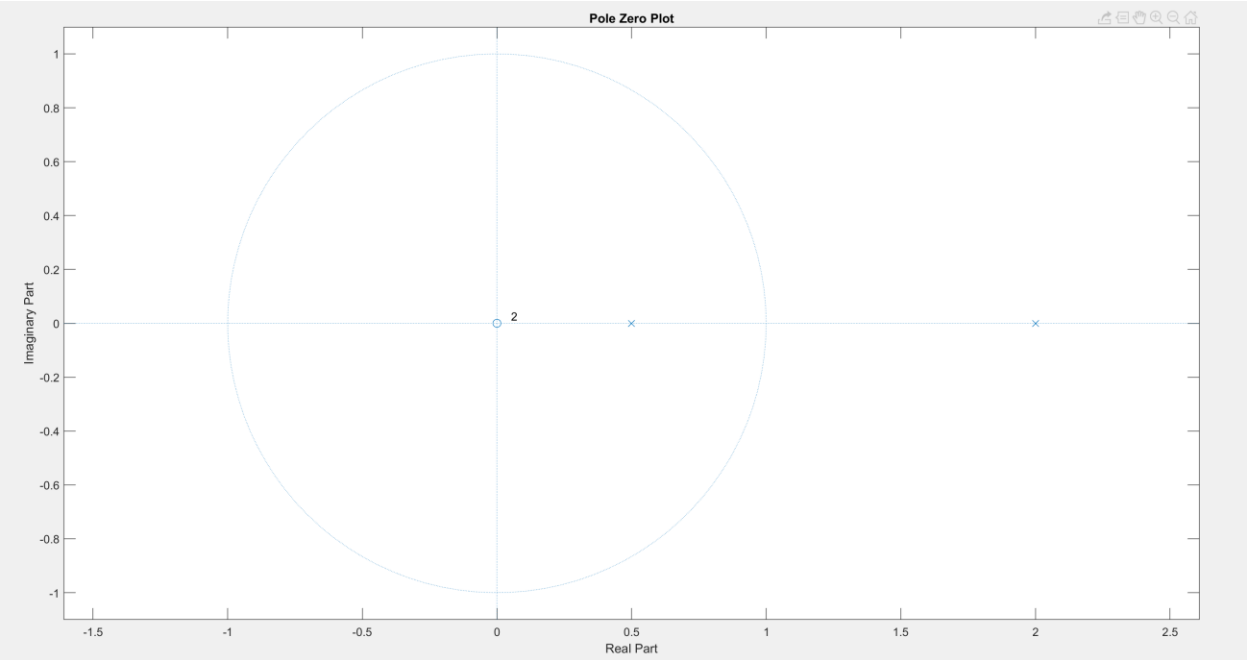
C8:

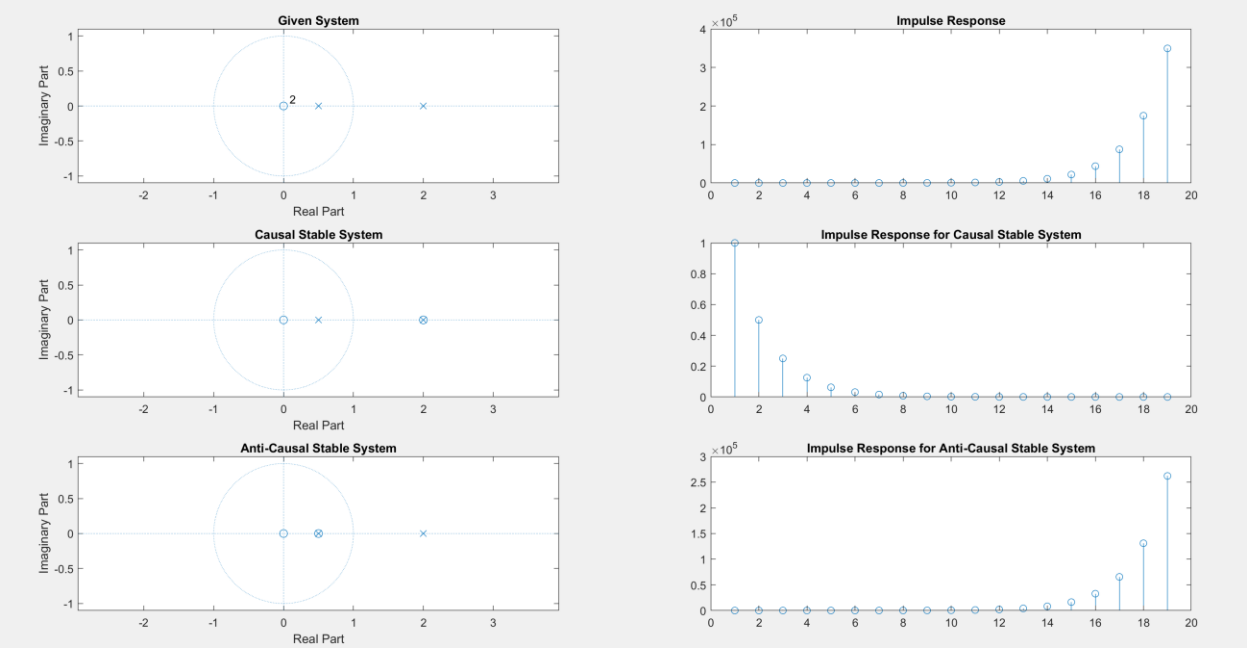
Code:

```
clc;
clearvars;

num = [1];
den = [ 1 -2.5 1];
figure(1);
zplane(num,den);
title("Pole Zero Plot");

num1 = [1 -2];
num2 = [1 -.5];

figure(2)
subplot(3,2,1)
zplane(num,den);
title('Given System');

subplot(3,2,2)
x = impz(num,den);
stem(x); title('Impulse Response');

subplot(3,2,3);
zplane(num1,den); title('Causal Stable System');

subplot(3,2,4)
y = impz(num1, den);
stem(y); title('Impulse Response for Causal Stable
System');

subplot(3,2,5);
zplane(num2,den); title('Anti-Causal Stable System');

subplot(3,2,6)
z = impz(num2, den);
```

```
stem(z); title('Impulse Response for Anti-Causal Stable System');
```

Output:





Comments:

For causal and stable system, the ROC is exterior and there cannot be any pole $|z|>2$.

For anti-causal and stable system, the ROC is interior and there cannot be any pole $|z|<0.5$.

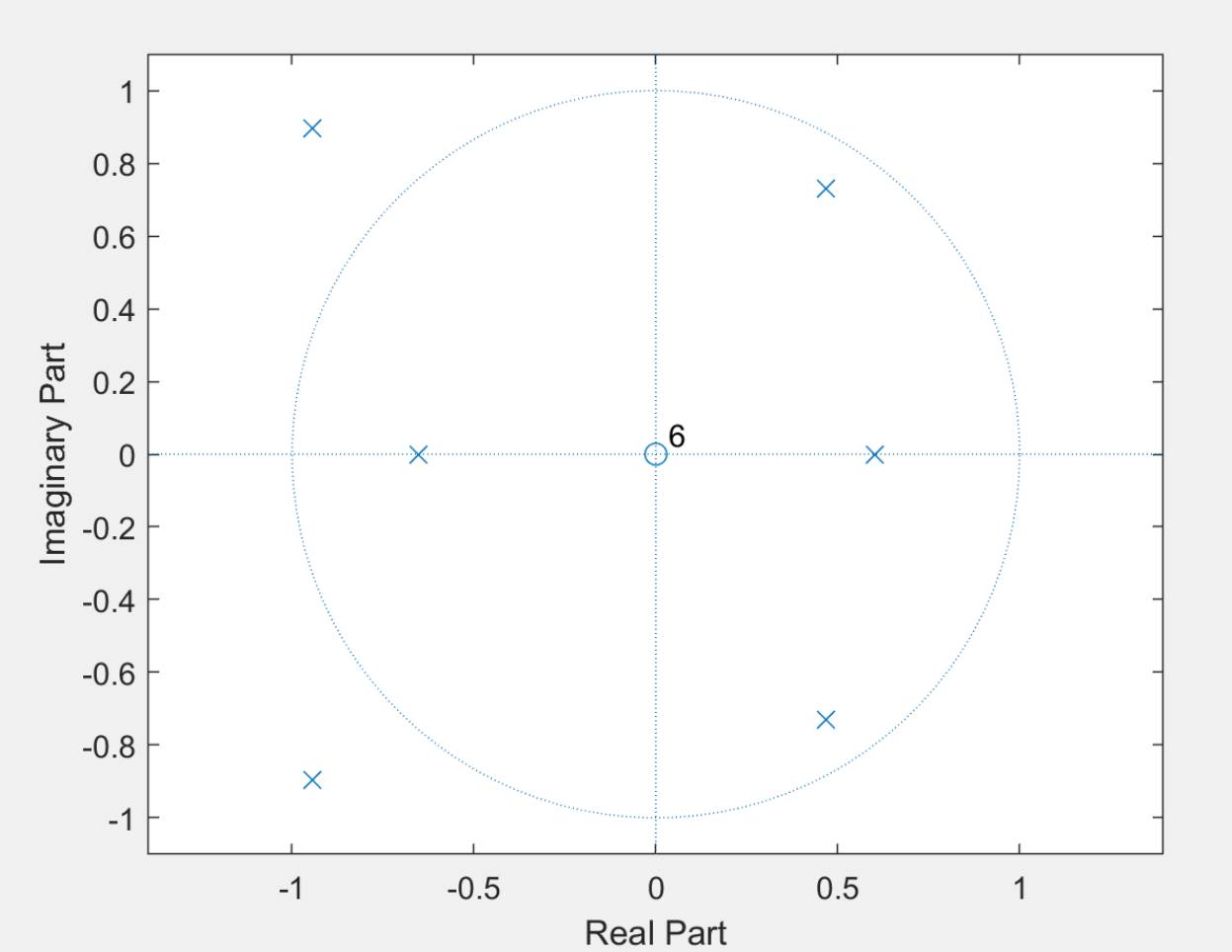
Stability Test:

Unstable System:

Code:

```
clc;
clearvars;

clc
clear all
close all
num = [1];
den = [1 1 1/3 -3/6 1 1/8 -7/14];
zplane(num,den)
K = isStable(den);

function [K] = isStable(A)
  l = length(A);
 K = zeros(1,l);
 temp = 1;
for i = 1:l
    K(l-i+1)=A(end);
    if abs(K(l-i+1))>1
     disp('Unstabale System');
     temp = 0;
     break;
    end
    A = (A - K(l-i+1)*fliplr(A))/(1-K(l-i+1)^2);
    A(end)=[];
end
if temp == 1
    disp('Stable System');
end
end
```

Output:



```
Unstabale System
fx >>
```

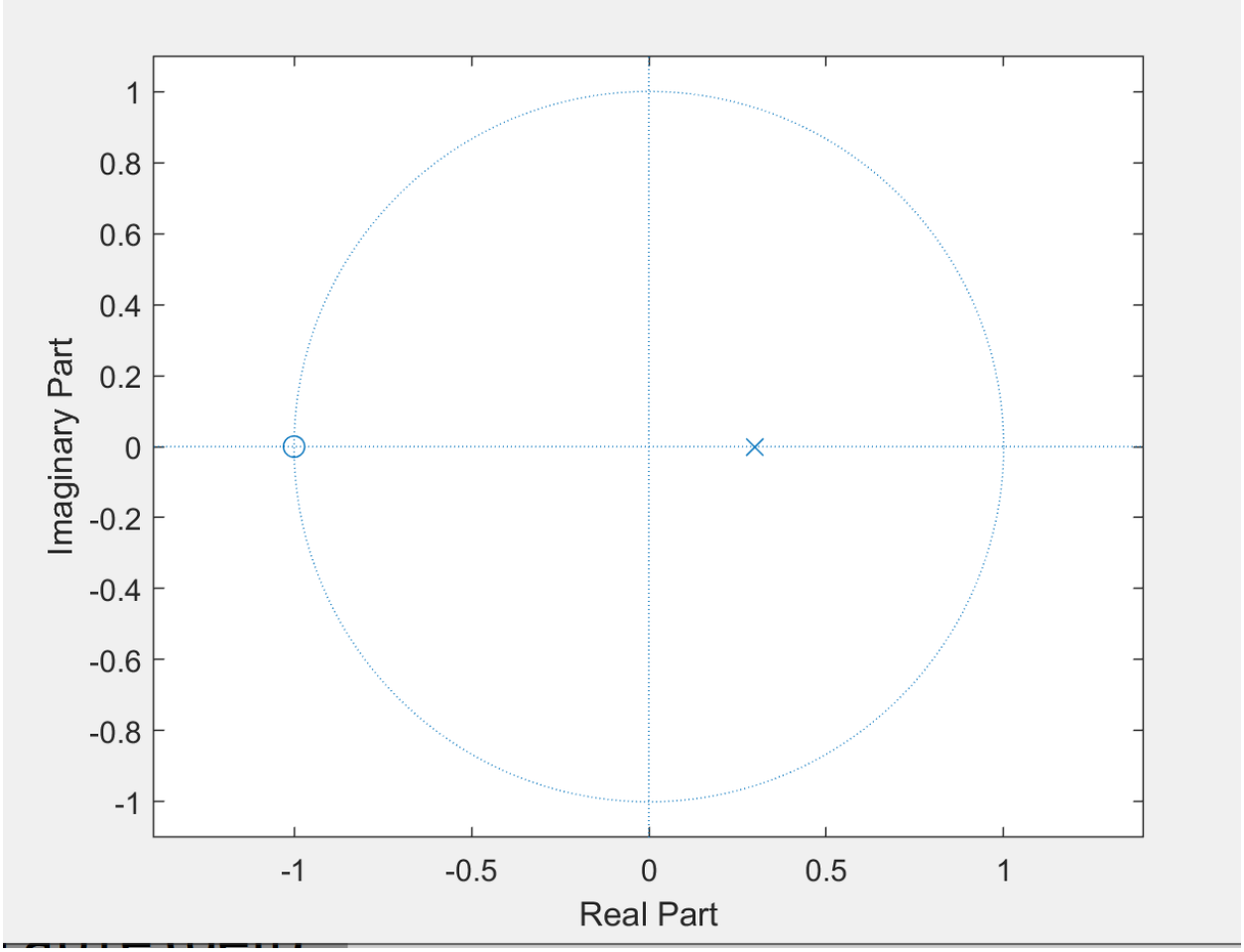
Stable System:

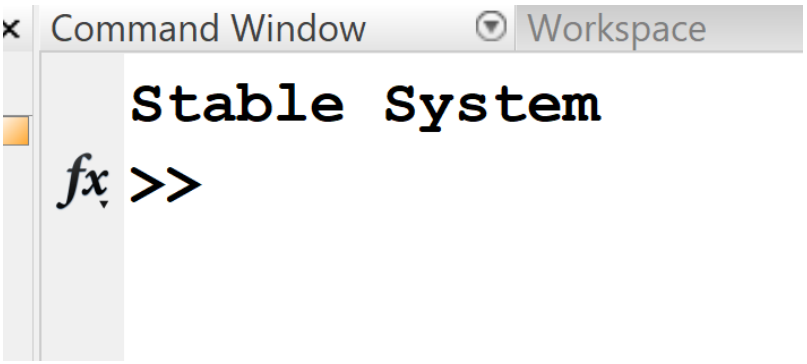
Code:

```
clc;
clearvars;

clc
clear all
close all
num = [1 1];
den = [1 -.3 ];
zplane(num,den)
K = isStable(den);

function [K] = isStable(A)
  l = length(A);
 K = zeros(1,l);
 temp = 1;
for i = 1:l
    K(l-i+1)=A(end);
    if abs(K(l-i+1))>1
     disp('Unstabale System');
     temp = 0;
     break;
    end
```

```
    A = (A - K(l-i+1)*fliplr(A))/(1-K(l-i+1)^2);
    A(end)=[];
end
if temp == 1
    disp('Stable System');
end
end
```

Output:




Command Window
Workspace
Stable System
>>