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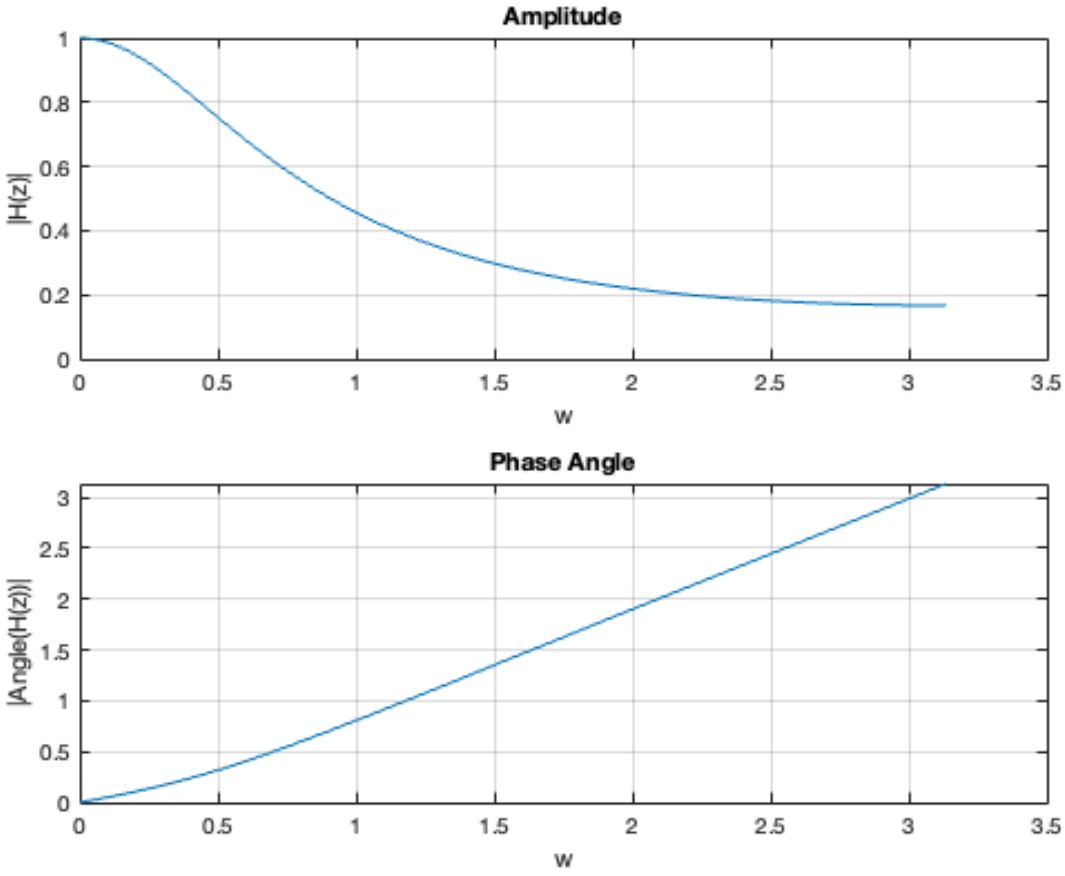
```
clc; close all; clear;

% Setting up required functions
u = @(n)double(n>=0);
del = @(n)double(n==0);
```

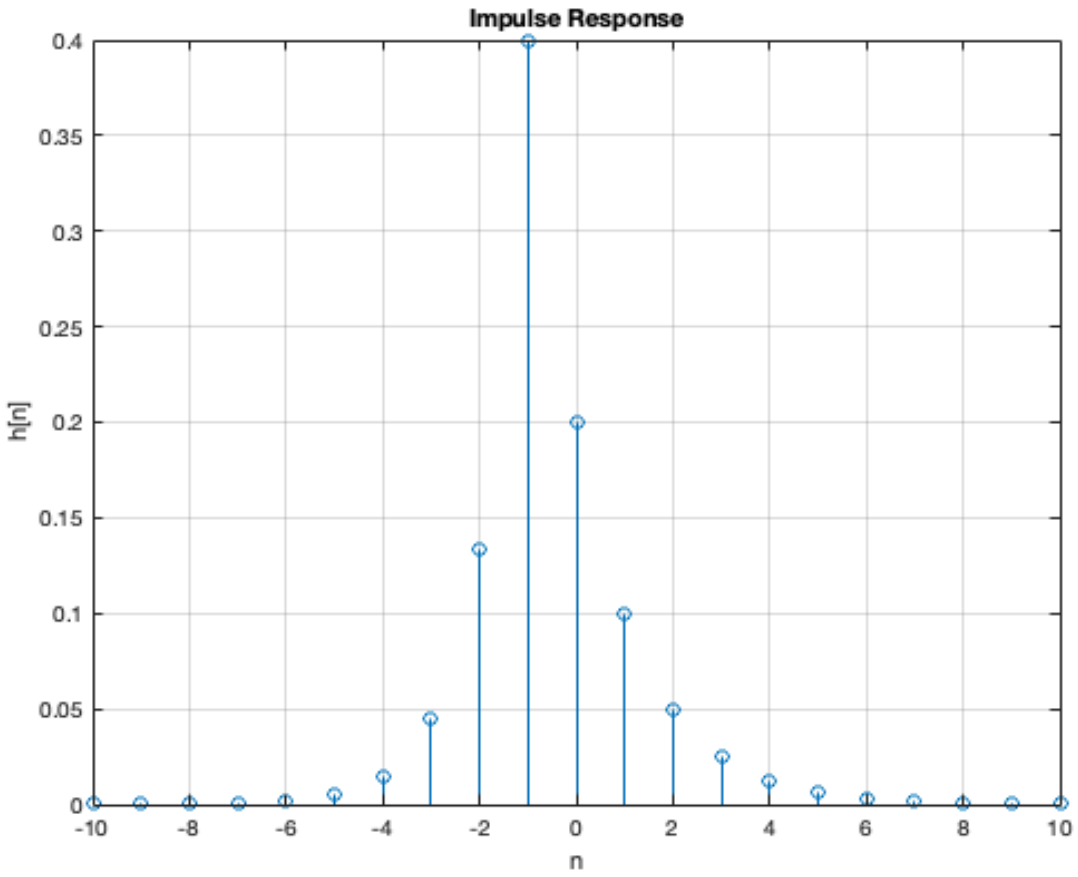
QUESTION 1

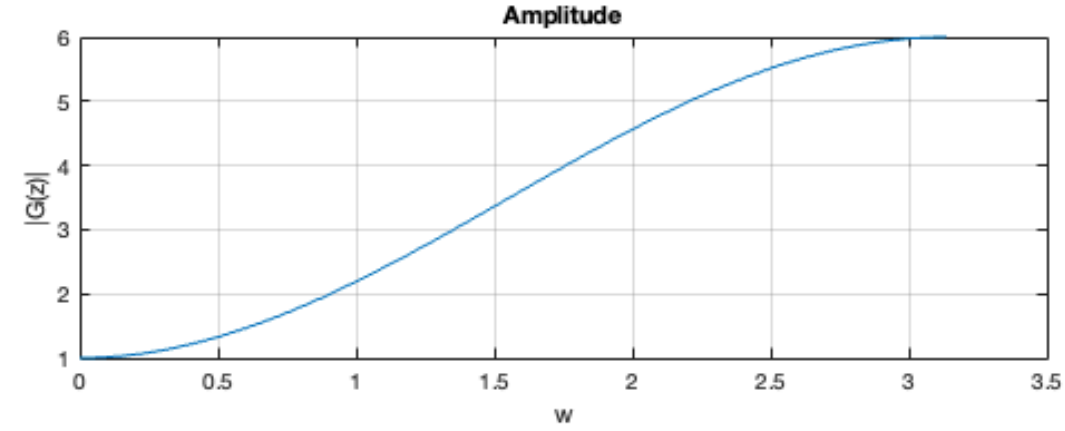
```
% a) Transfer Function H(z):
% H(z) = 1/(-1+3.5z^-1-1.5z^-2)
% ROC: |0.5| < z < |3|

b = [1];
a = [-1,3.5,-1.5];

[H, w] = freqz(b,a);

figure;
subplot(2,1,1);
plot(w,abs(H));
xlabel("w");
ylabel("|H(z)|");
title("Amplitude");
grid on;

subplot(2,1,2);
plot(w,angle(H));
xlabel("w");
ylabel("|Angle(H(z))|");
title("Phase Angle");
grid on;

% Impulse Response: 0.2*0.5^nu(n) + 1.2*3^nu(-n-1)
% Derivation: https://drive.google.com/file/
d/1bgMN640S_4OW6PIggLRphnLC7_SCfPdP/view?usp=drivesdk

n = -10:10;
h = 0.2*(0.5.^n).*u(n) + 1.2*(3.^n).*u(-n-1);

figure;
stem(n,h);
grid on;
```

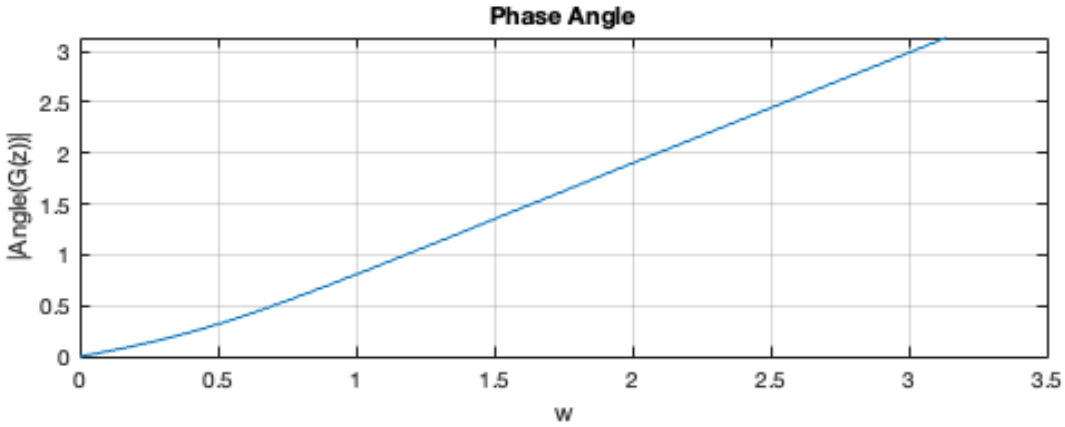
```
ylabel("h[n]");
xlabel("n");
title("Impulse Response");

% Stable Inverse Response (Frequency Domain)

b = [-1,3.5,-1.5];
a = [1];

[G, w] = freqz(b,a);

figure;
subplot(2,1,1);
plot(w,abs(G));
xlabel("w");
ylabel("|G(z)|");
title("Amplitude");
grid on;

subplot(2,1,2);
plot(w,angle(H));
xlabel("w");
ylabel("|Angle(G(z))|");
title("Phase Angle");
grid on;

% Stable Inverse Response (Time Domain)

n = -10:10;
g = -1.5*del(n-2)+3.5*del(n-1)-del(n);

figure;
stem(n,h);
grid on;
ylabel("h[n]");
xlabel("n");
title("Inverse Impulse Response");

% Check H(z)*G(z) = 1 ?

HG = H.*G;

figure;
plot(w,abs(HG));
xlabel("w");
ylabel("|G(z)|");
title("Amplitude");
grid on;

% Yes, = 1

% Check h(n) convolve g(n) ?

n = -20:20;
```

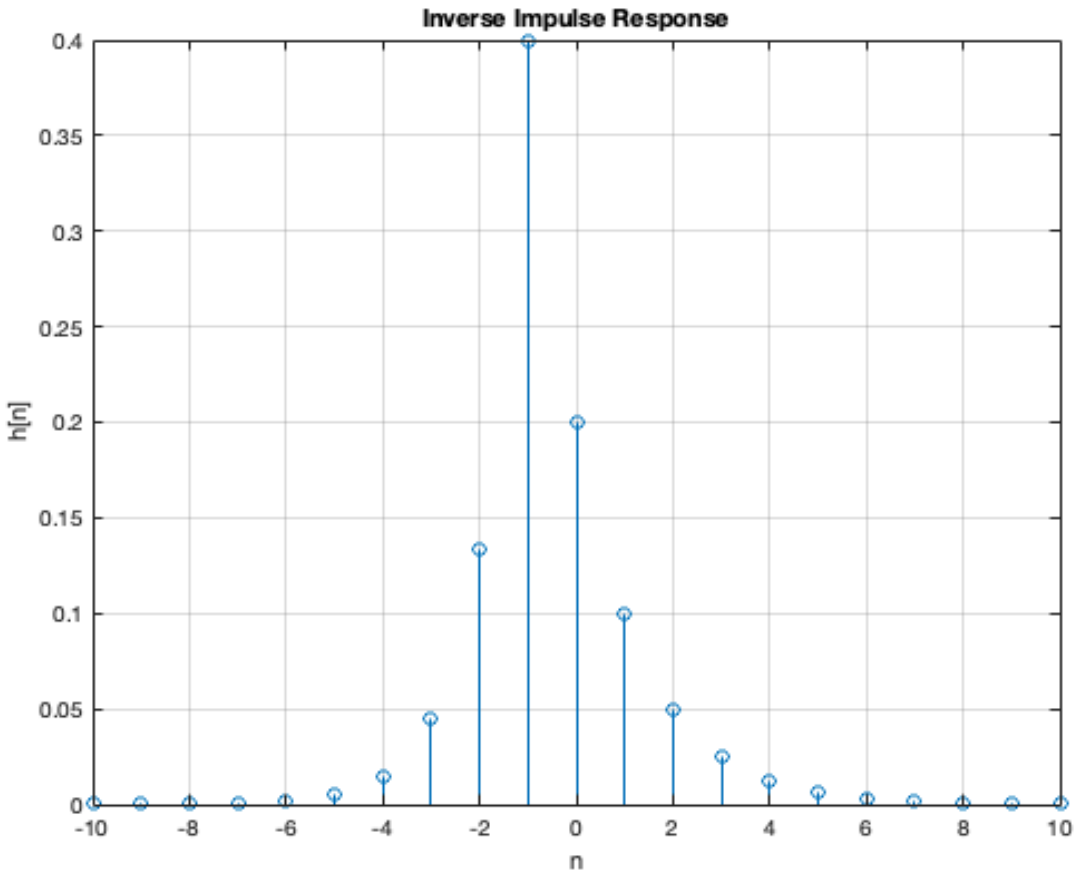
```
hg = conv(h,g);

figure;
stem(n,hg);
ylabel("hg[n]");
xlabel("n");
title("Inverse Impulse Response");

% Yes, = direct delta
```

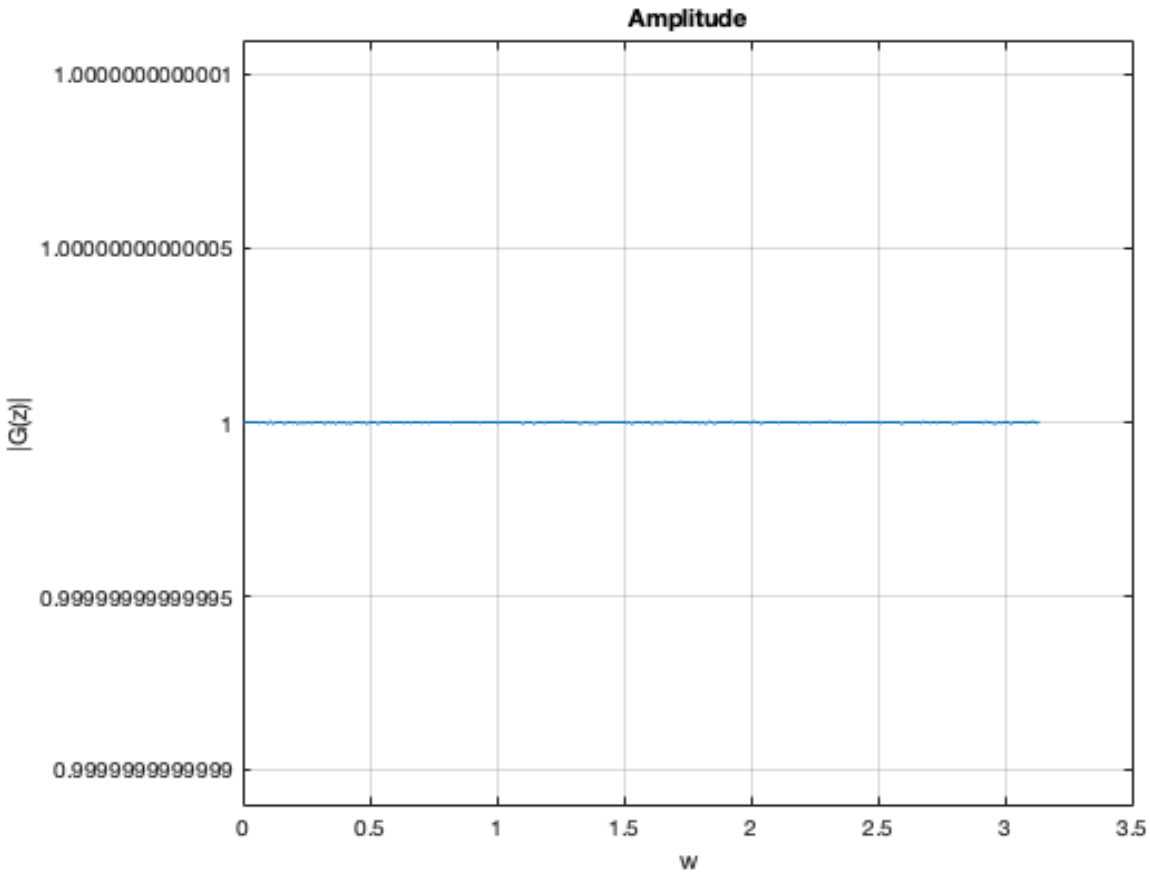


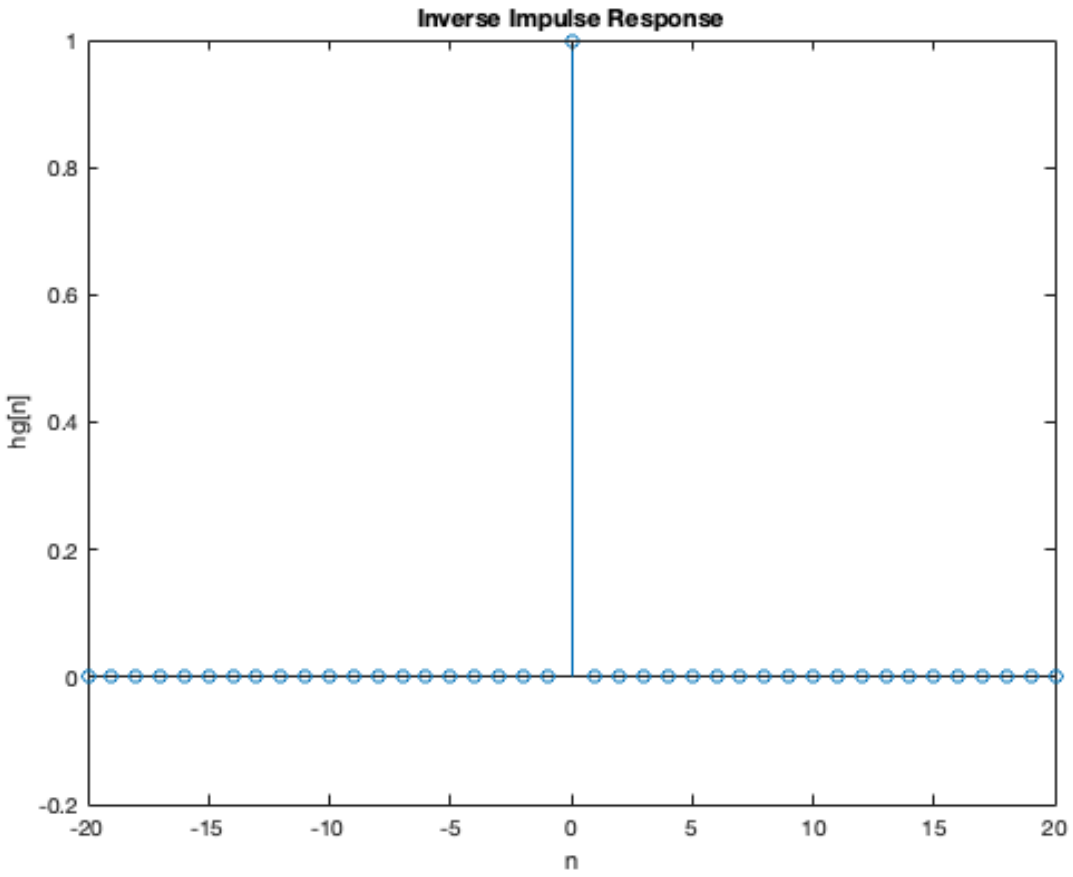

Impulse Response
h[n]
n
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-10
-8
-6
-4
-2
0
2
4
6
8
10


Amplitude
|G(z)|
w
1
2
3
4
5
6
0
0.5
1
1.5
2
2.5
3
3.5


Phase Angle
|Angle(G(z))|
w
0
0.5
1
1.5
2
2.5
3
0
0.5
1
1.5
2
2.5
3
3.5


Inverse Impulse Response
h[n]
n
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-10
-8
-6
-4
-2
0
2
4
6
8
10

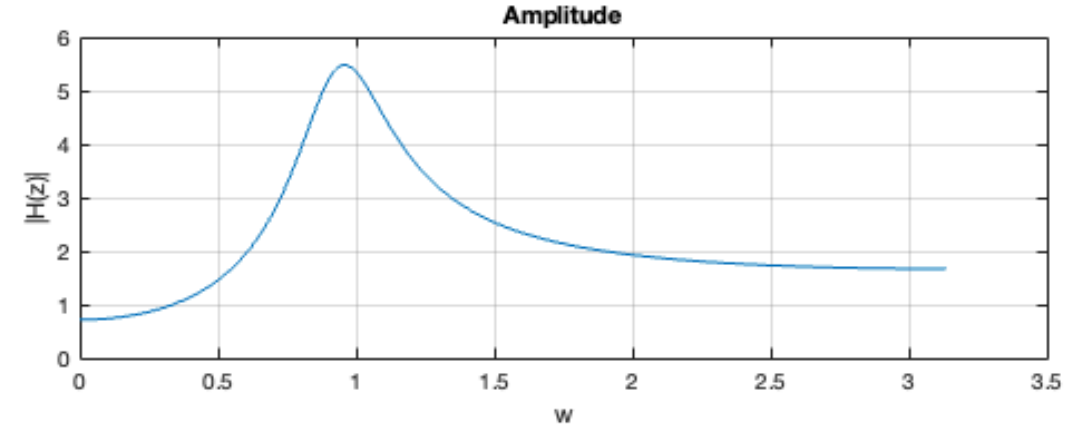

Amplitude
1.0000000000001
1.0000000000005
1
0.9999999999995
0.9999999999999
|G(z)|
0
0.5
1
1.5
2
2.5
3
3.5
w

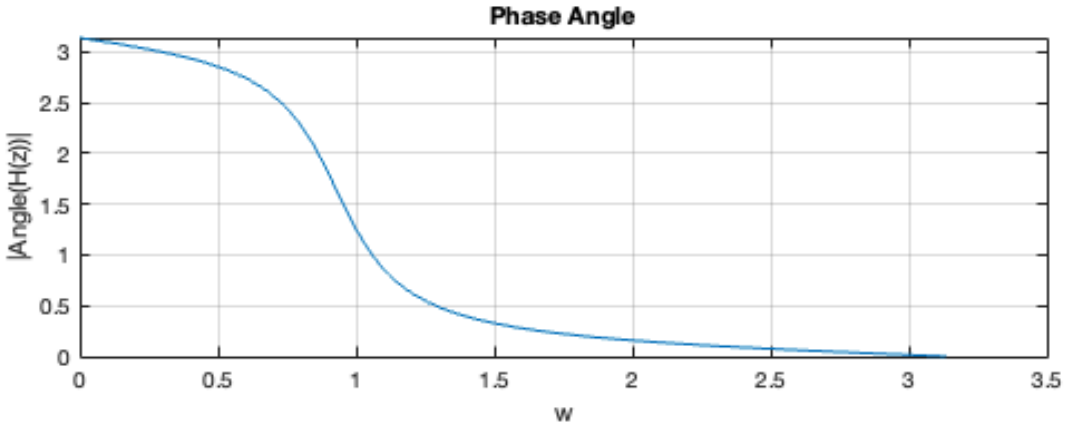


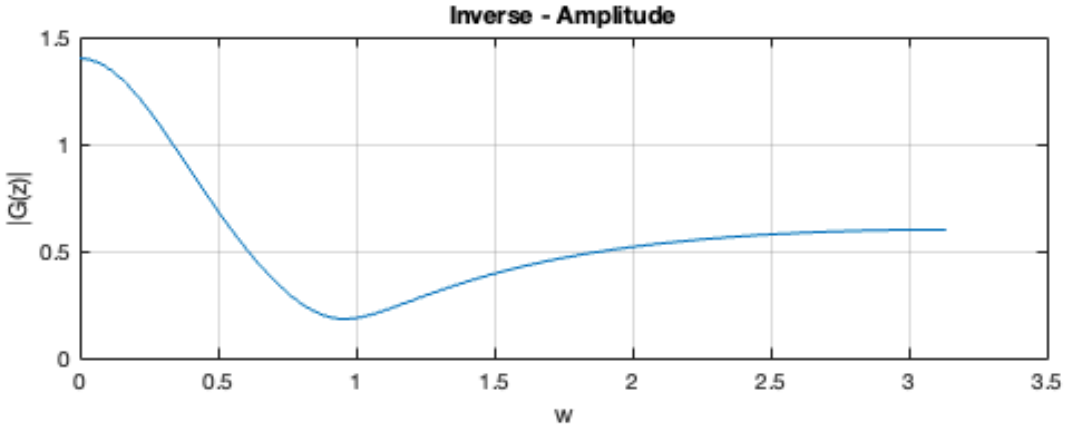
QUESTION 2

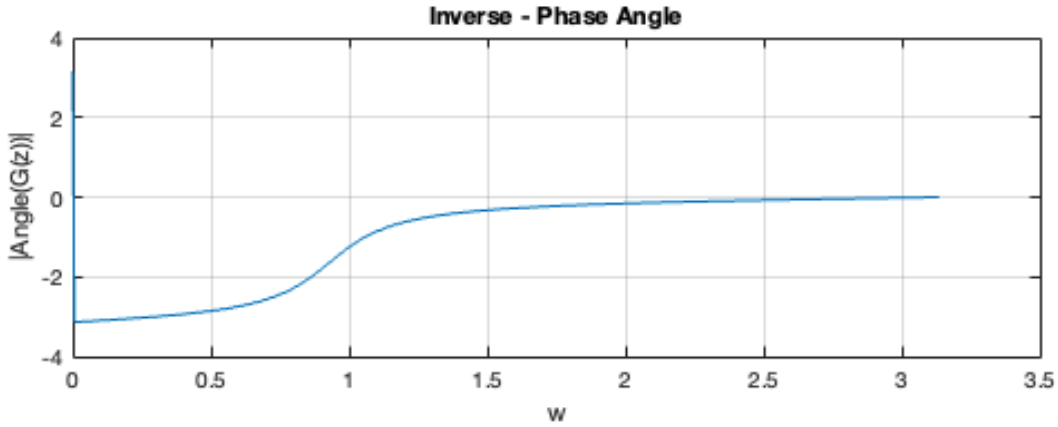
```
% Inverse (freq domain)

b = [1,-2.5,1];
a = [1,-1,0.7];

[H,w] = freqz(b,a);

figure;
subplot(2,1,1);
plot(w,abs(H));
xlabel("w");
ylabel("|H(z)|");
title("Amplitude");
grid on;

subplot(2,1,2);
plot(w,angle(H));
xlabel("w");
ylabel("|Angle(H(z))|");
title("Phase Angle");
```

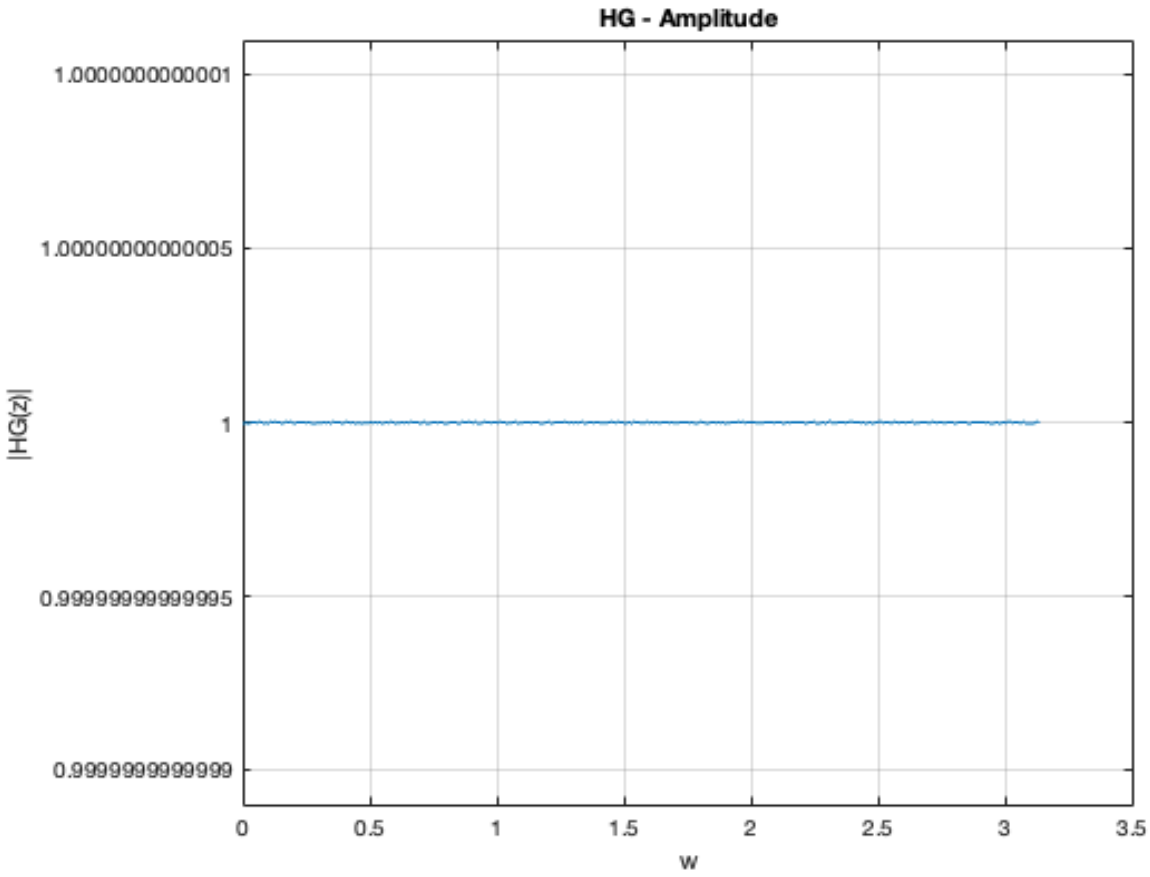
```
grid on;

b = [1,-1,0.7];
a = [1,-2.5,1];

[G,w] = freqz(b,a);

figure;
subplot(2,1,1);
plot(w,abs(G));
xlabel("w");
ylabel("|G(z)|");
title("Inverse - Amplitude");
grid on;

subplot(2,1,2);
plot(w,angle(G));
xlabel("w");
ylabel("|Angle(G(z))|");
title("Inverse - Phase Angle");
grid on;

% checking H(w)G(w)

HG = H.*G;
figure;
plot(w,abs(HG));
xlabel("w");
ylabel("|HG(z)|");
title("HG - Amplitude");
grid on;

% equal one!
```


Amplitude
|H(z)|
w
0
1
2
3
4
5
6
0
0.5
1
1.5
2
2.5
3
3.5


Phase Angle
|Angle(H(z))|
w
0
0.5
1
1.5
2
2.5
3
0
0.5
1
1.5
2
2.5
3
3.5


Inverse - Amplitude
|G(z)|
w
0
0.5
1
1.5
2
2.5
3
3.5

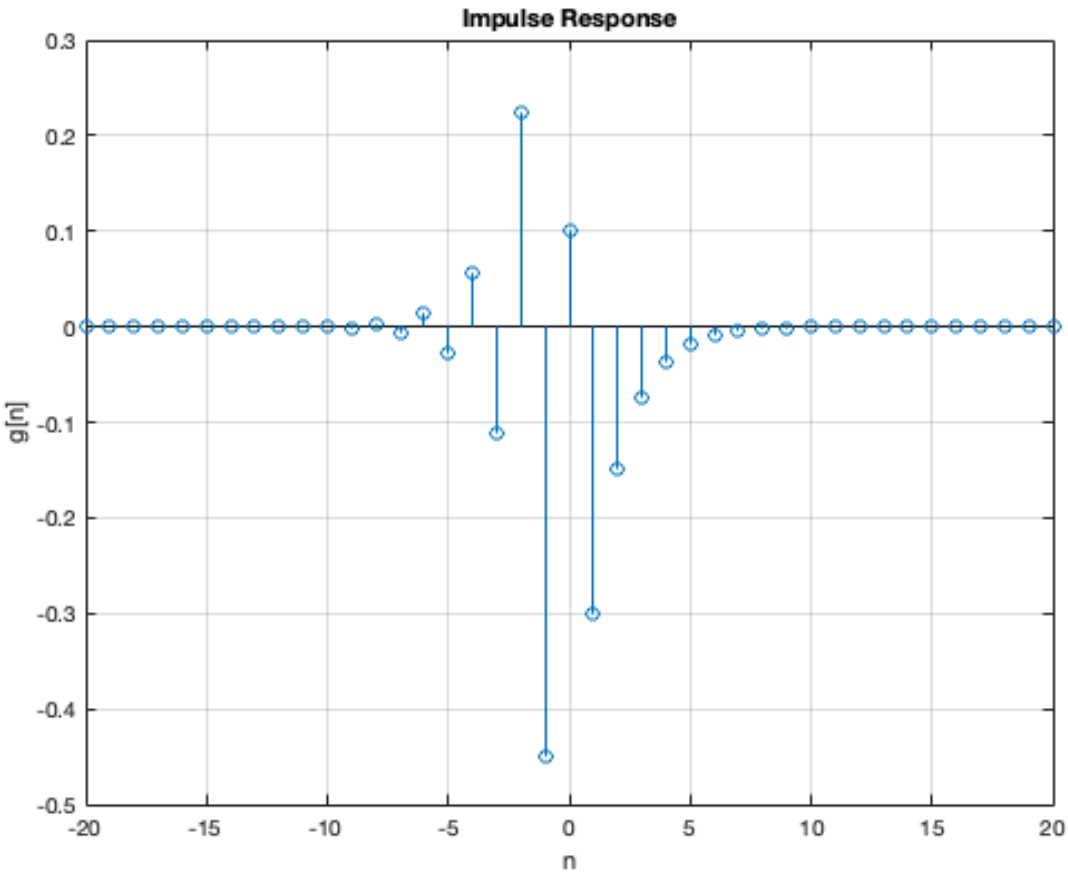

Inverse - Phase Angle
|Angle(G(z))|
w
-4
-2
0
2
4
0.5
1
1.5
2
2.5
3
3.5

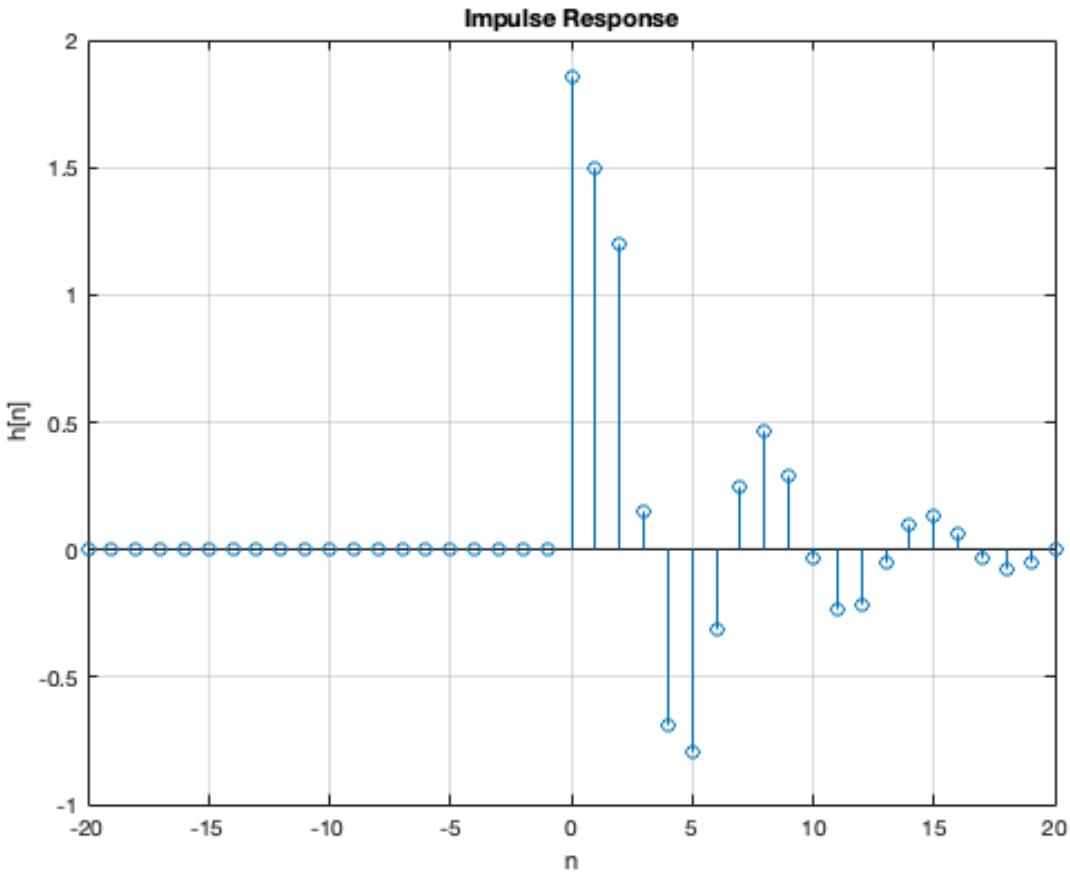


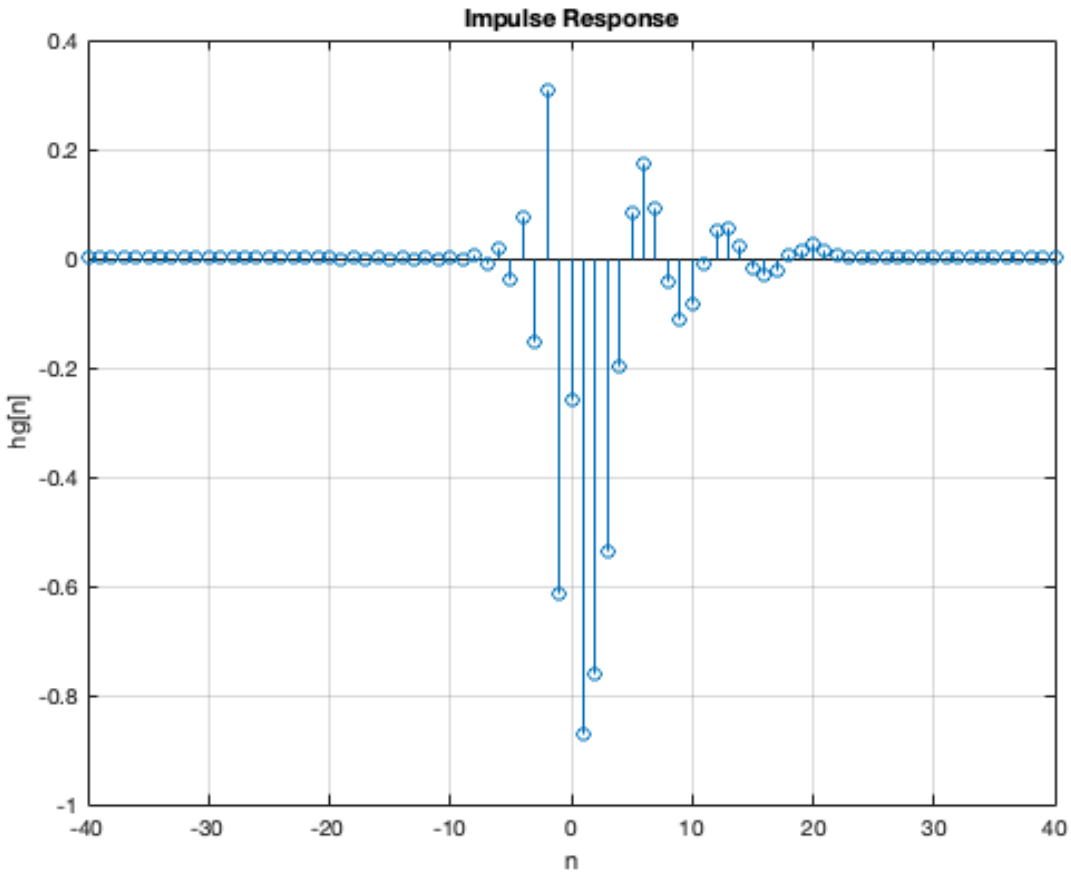
Inverse (time domain)

```
b = [1,-1,0.7];
a = [1,-2.5,1];

[r,p,k] = residuez(b,a)

n = -20:20;

g = k*del(n) + r(1).*((-p(1)).^n).*u(-n-1) + r(2).*((p(2)).^n).*u(n);

figure;
stem(n,g);
grid on;
ylabel("g[n]");
xlabel("n");
title("Impulse Response");

b = [1,-2.5,1];
a = [1,-1,0.7];

[r,p,k] = residuez(b,a);
```

```
h = k*del(n) + r(1).*(-(p(1)).^n).*u(n) + r(2).*(-(p(2)).^n).*u(n);

figure;
stem(n,h);
grid on;
ylabel("h[n]");
xlabel("n");
title("Impulse Response");

hg = conv(h,g);
n = -40:40;
figure;
stem(n,hg);
grid on;
ylabel("hg[n]");
xlabel("n");
title("Impulse Response");

% e: yes


r =

    0.9000
   -0.6000


p =

    2.0000
    0.5000


k =

    0.7000
```


Impulse Response
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
g[n]
-20
-15
-10
-5
0
5
10
15
20
n


Impulse Response
h[n]
n
2
1.5
1
0.5
0
-0.5
-1
-20
-15
-10
-5
0
5
10
15
20



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