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Session: Thursday, 2-4:50

LAB 4
EE110B

1) Determine the expression of the frequency response:

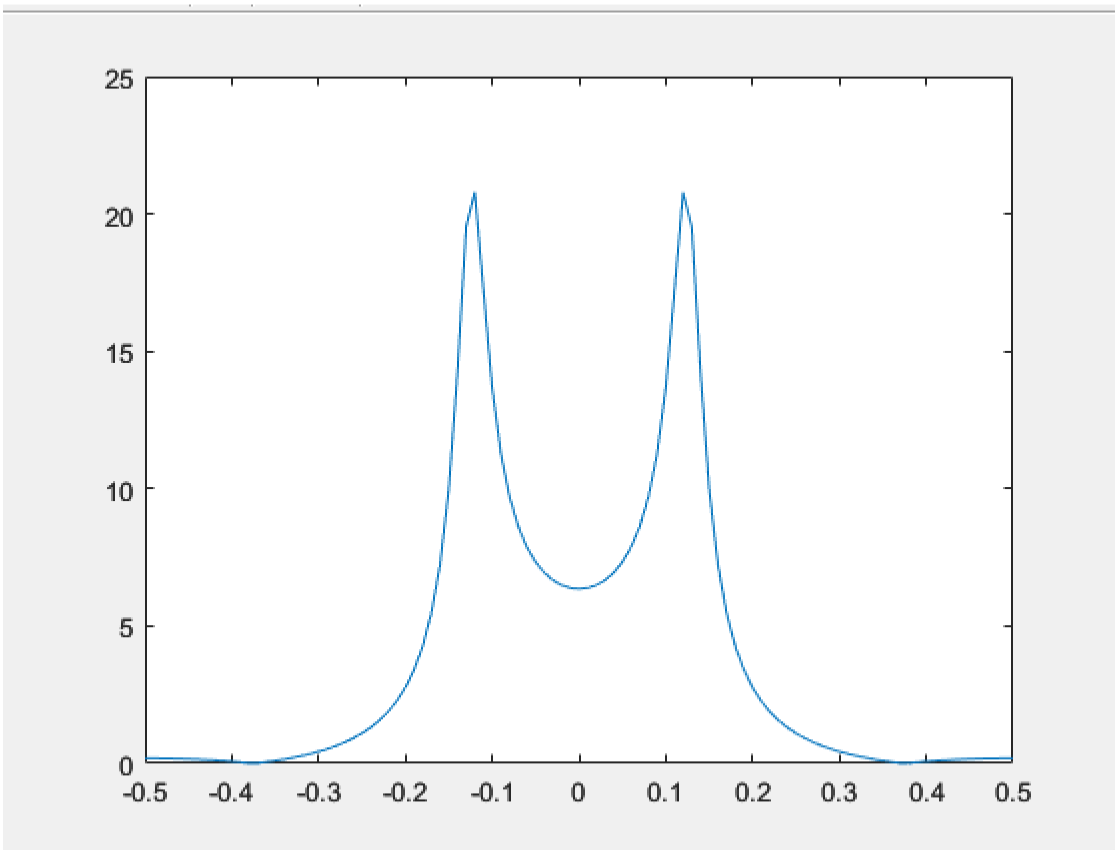
```
close all;clf;clc;clear;
f=-0.5:0.01:0.5;
num= 1+sqrt(2).*exp(-1j*2*pi*f)+exp(-1j*2*pi*f*2);
den=1-0.9.*sqrt(2).*exp(-1j*2*pi*f)+0.81*(exp(-1j*2*pi*f*2));

H= num./den;
```

2) Plot the amplitude and the phase response:

For the coding part:

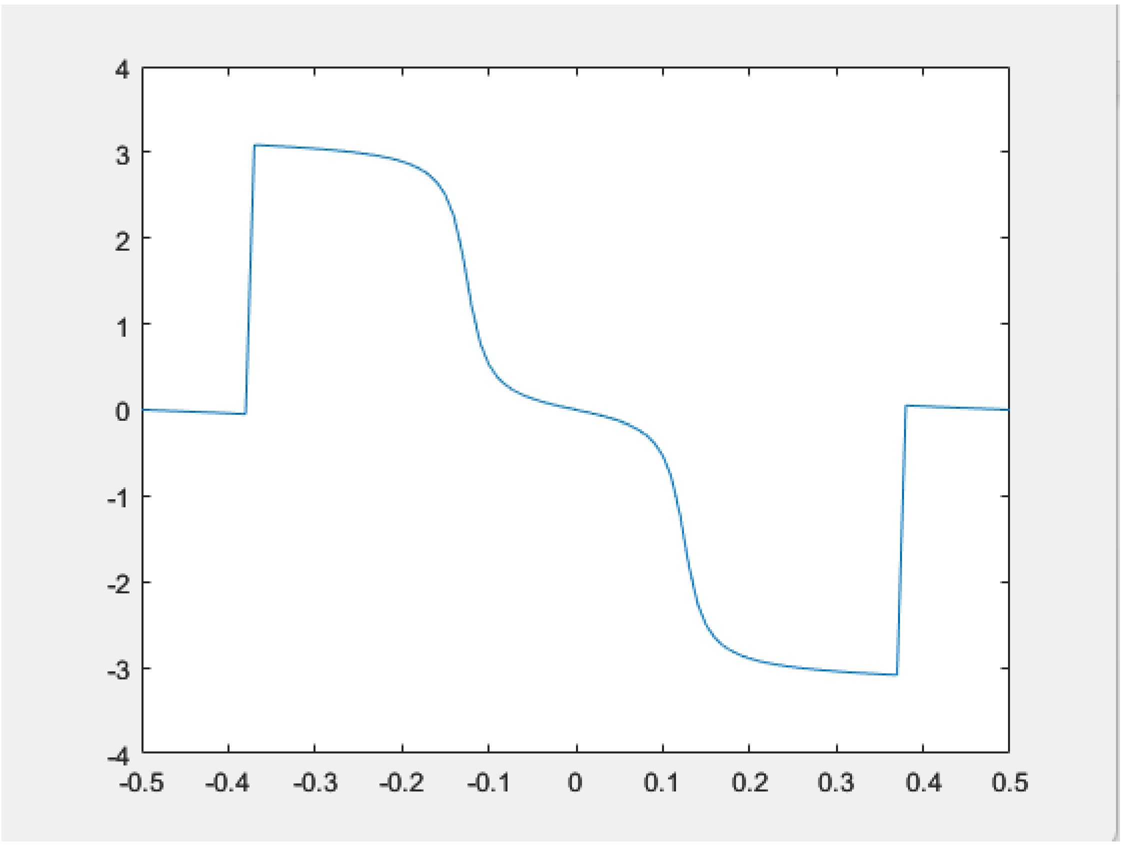
```
close all;clf;clc;clear;
f=-0.5:0.01:0.5;
num= 1+sqrt(2).*exp(-1j*2*pi*f)+exp(-1j*2*pi*f*2);
den=1-0.9.*sqrt(2).*exp(-1j*2*pi*f)+0.81*(exp(-1j*2*pi*f*2));

H= num./den;
figure(1),plot(f,abs(H));
 figure(2),plot(f,angle(H));
```

For the amplitude response:



The position of peaks for this amplitude response is around 22 when -0.5<f<0.5.
The valley of this amplitude response is around 6.35 when -0.5<f<0.5

For the phase response:



The position of peaks for this phase response is around 3.09 when -0.5<f<0.5.
The valley of this phase response is around -3.09 when -0.5<f<0.5

3)

a) $y[-1] = y[-2] = 0$ and $x[n] = \cos(\frac{3\pi}{4}n)u[n]$.

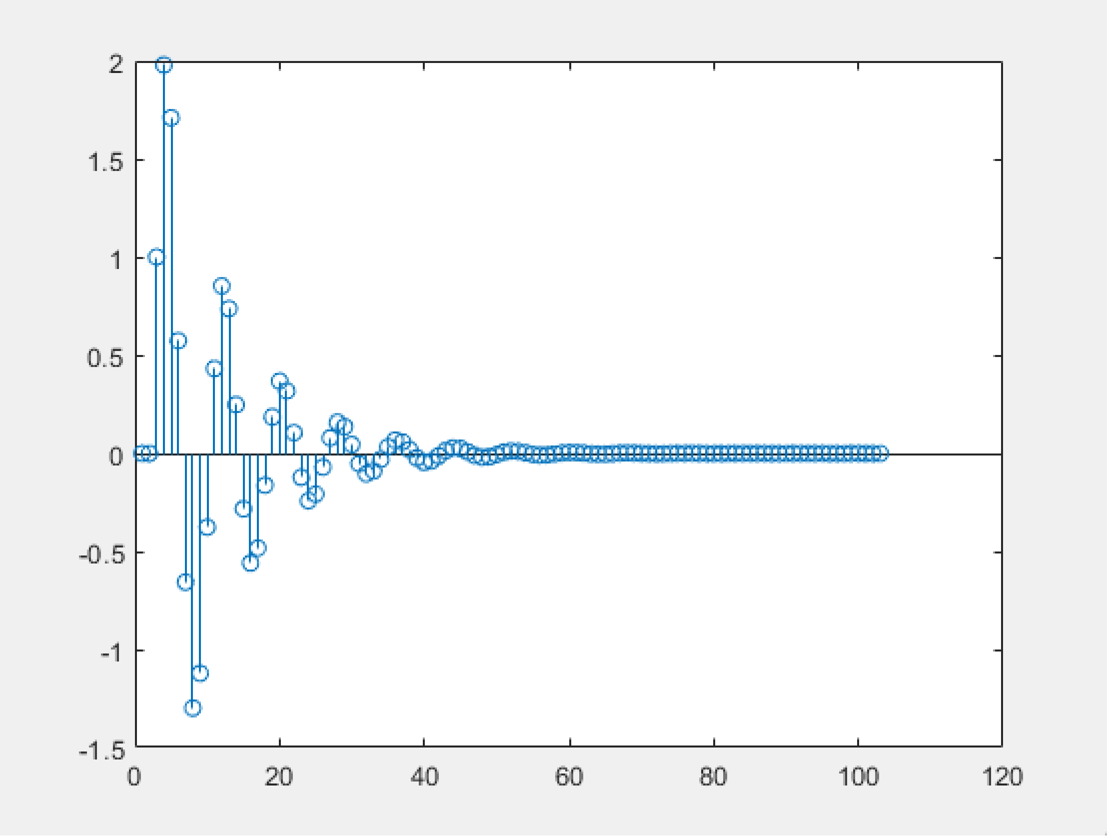
Recursive formula to compute and plot the y[n] for n>0:
The recursive formula is:

$$y[n] = 1.8\cos(\pi/4)y[n-1] - 0.81y[n-2] + x[n] - 2\cos(3\pi/4)x[n-1] + x[n-2]$$

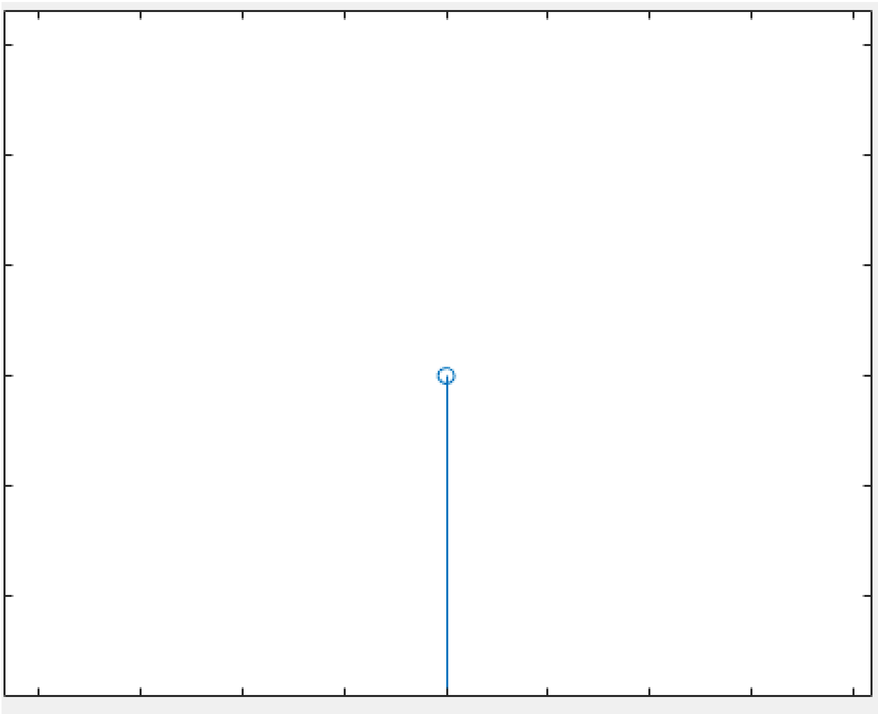
For the coding part:

```
n=0:100;
n=n';
x(1)=0;
x(2)=0;
y(1)=0;
y(2)=0;
x(3:103)=cos(3/4*pi*n);
y(3:103)= zeros(101,1);
for n=0:100
    y(n+3)= 1.8*cos(pi/4).*y(n+2)-0.81*y(n+1) + x(n+3) - 2*cos(3*pi/4)*x(n+2) + x(n+1);
end

figure(3),stem(y);
```

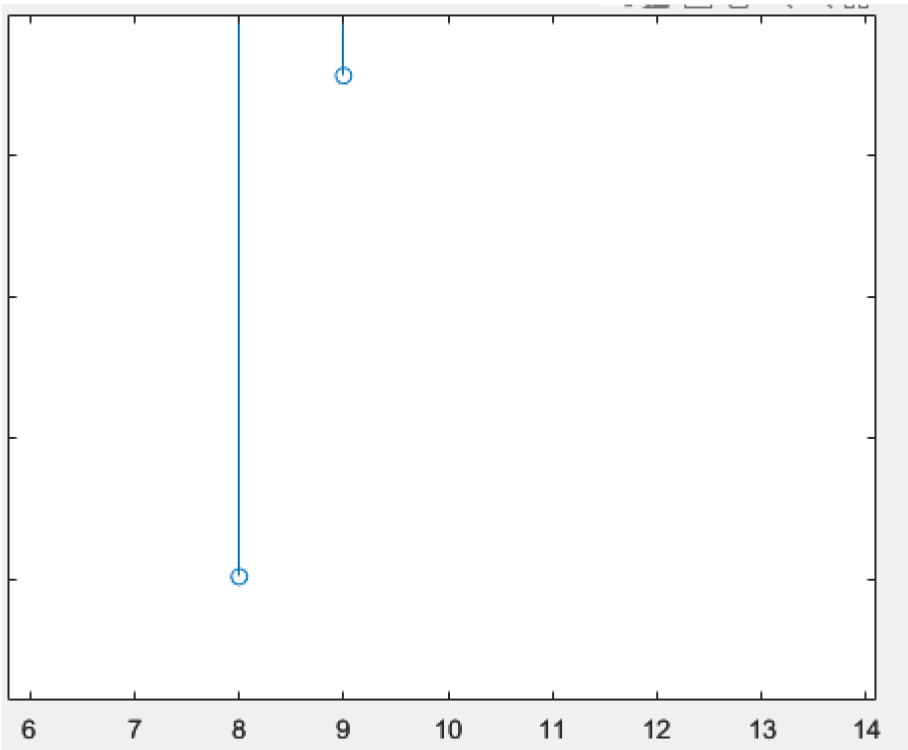
For the graph:



The position of peaks for this phase response is around 1.98 when n>=0.



The valley of this phase response is around -1.3 when n>=120



After plotting the sequence y[n] for n>=0, the sequence oscillates between -1.3 to 1.98 with a frequency of 3pi/4

b)

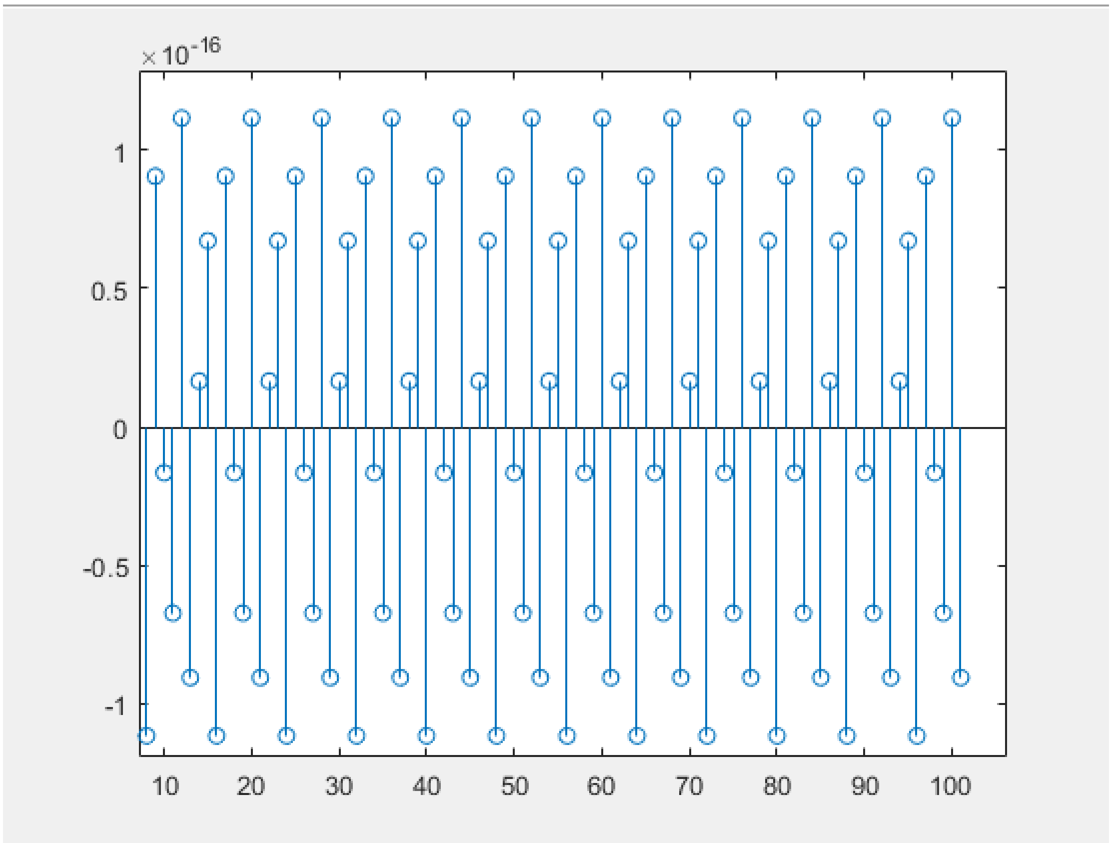
Now assume $x[n] = \cos(\frac{3\pi}{4}n)$ (without the step function $u[n]$). Compute and plot the output of the system, $y[n]$ for $n \geq 0$, using the following:

$$y[n] = |H(3/8)| \cos\left(\frac{3\pi}{4}n + \angle H(3/8)\right). \tag{2}$$

For the coding part:

```
clear;
f=3/8;
x(1)=0;
x(2)=0;
y(1)=0;
y(2)=0;
y=zeros(101,1);
num= 1+sqrt(2).*exp(-1j*2*pi*f)+exp(-1j*2*pi*f*2);
den=1-0.9.*sqrt(2).*exp(-1j*2*pi*f)+0.81*(exp(-1j*2*pi*f*2));
H=num./den;
for n=1:101
    y(n)= abs(H).*cos((3/4*pi*n)+angle(H));
end
figure(3),stem(y);
```

For the graphing part:



Comparison:

The result should be close to each other as n gets larger and larger everytime. As the observation by expanding y[n] to 1000 rows, and n from 1 to 1000, the result will get more closer and closer to the above result. The reason behind it is in part a, the transfer function of the system has a magnitude equals to 1 when the f= 3pi/4.

-> the output system is pretty close to the input signal with a phase angle of the transfer function.

For n from 0 to 1000

Editor - C:\Users\thong\Downloads\EE100B_LAB4_PART3B.m

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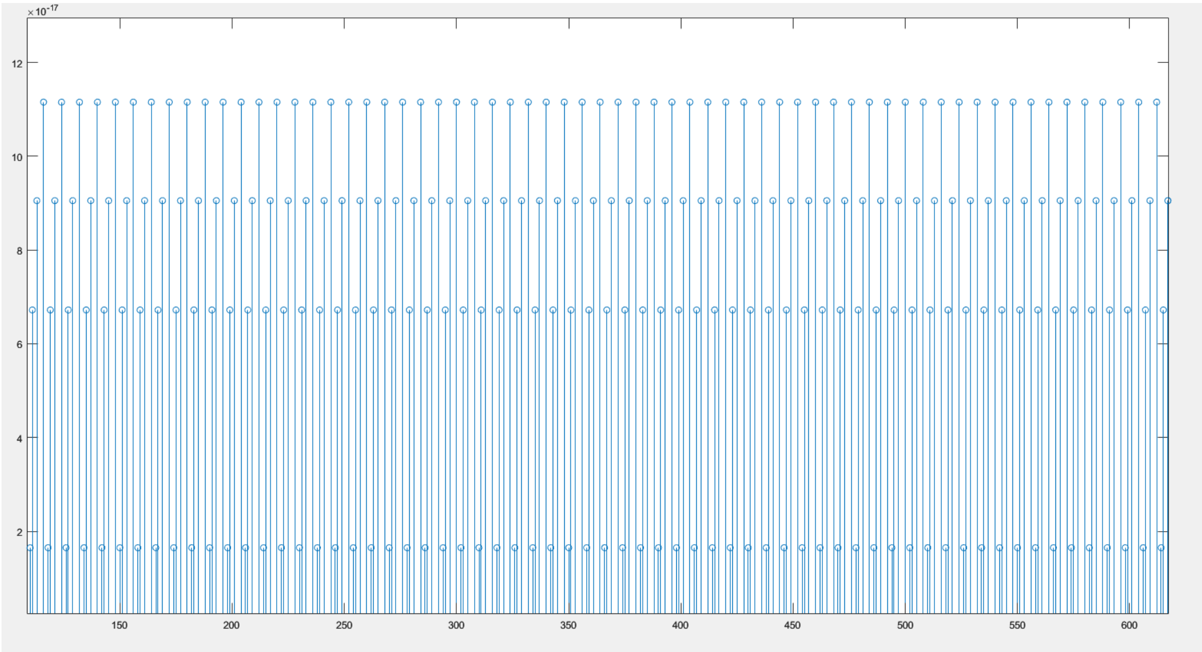
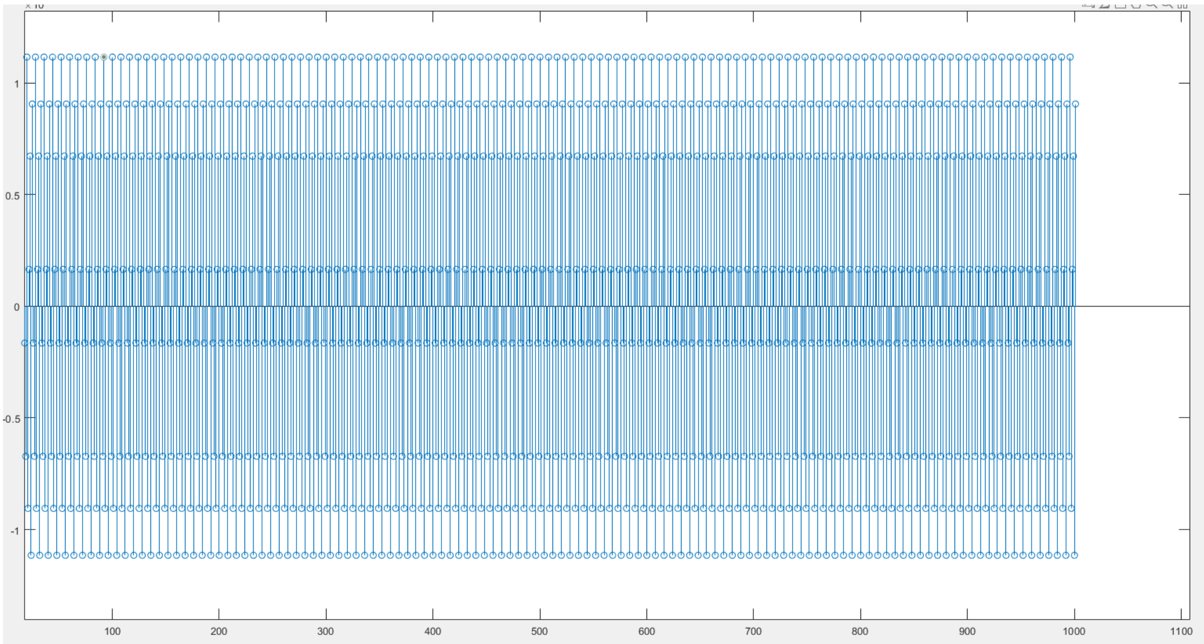
```
clear;
f=3/8;
x(1)=0;
x(2)=0;
y(1)=0;
y(2)=0;
y=zeros(1000,1);
num= 1+sqrt(2).*exp(-1j*2*pi*f)+exp(-1j*2*pi*f*2);
den=1-0.9.*sqrt(2).*exp(-1j*2*pi*f)+0.81*(exp(-1j*2*pi*f*2));
H=num./den;
for n=1:1001
    y(n)= abs(H).*cos((3/4*pi*n)+angle(H));
end
figure(3),stem(y);
```





4)

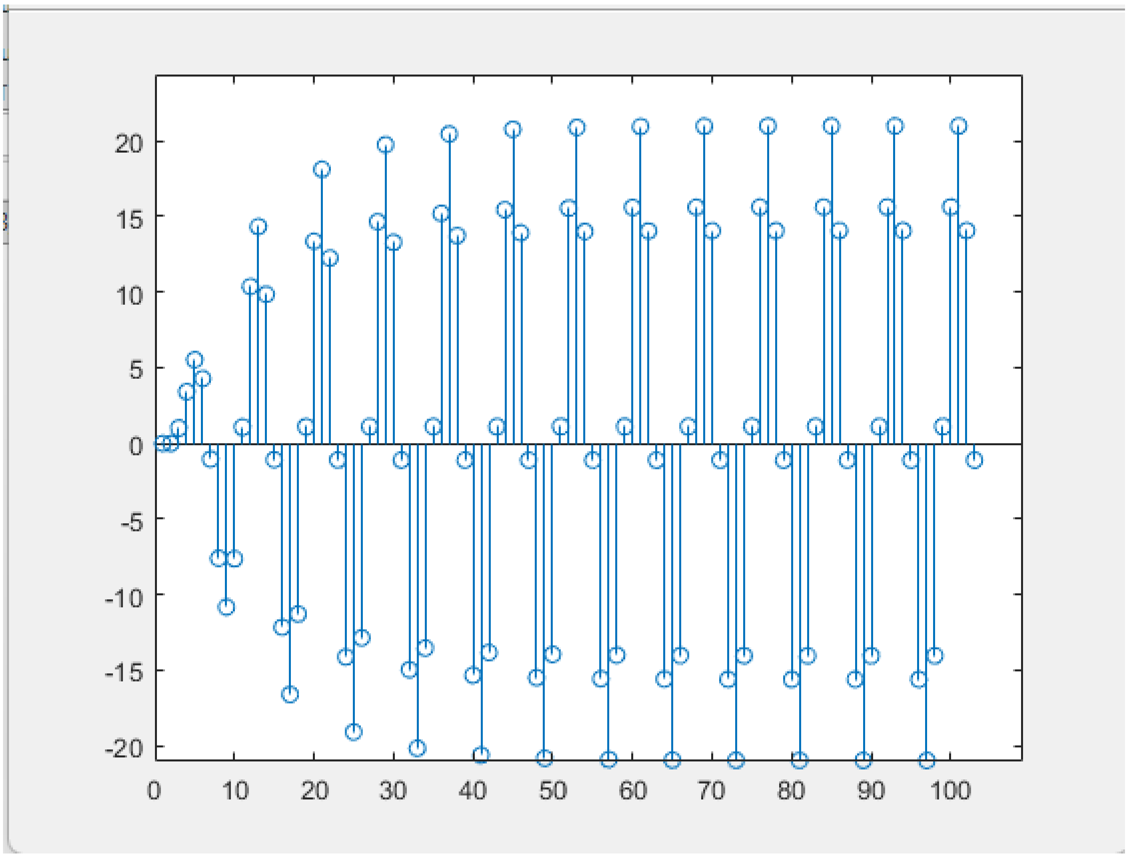
a) a) Assume $y[-1] = y[-2] = 0$ and $x[n] = \cos(\frac{\pi}{4}n)u[n]$. Apply the recursive formula (1) to compute and plot $y[n]$ for $n \geq 0$. Discuss your results.

For the coding part:

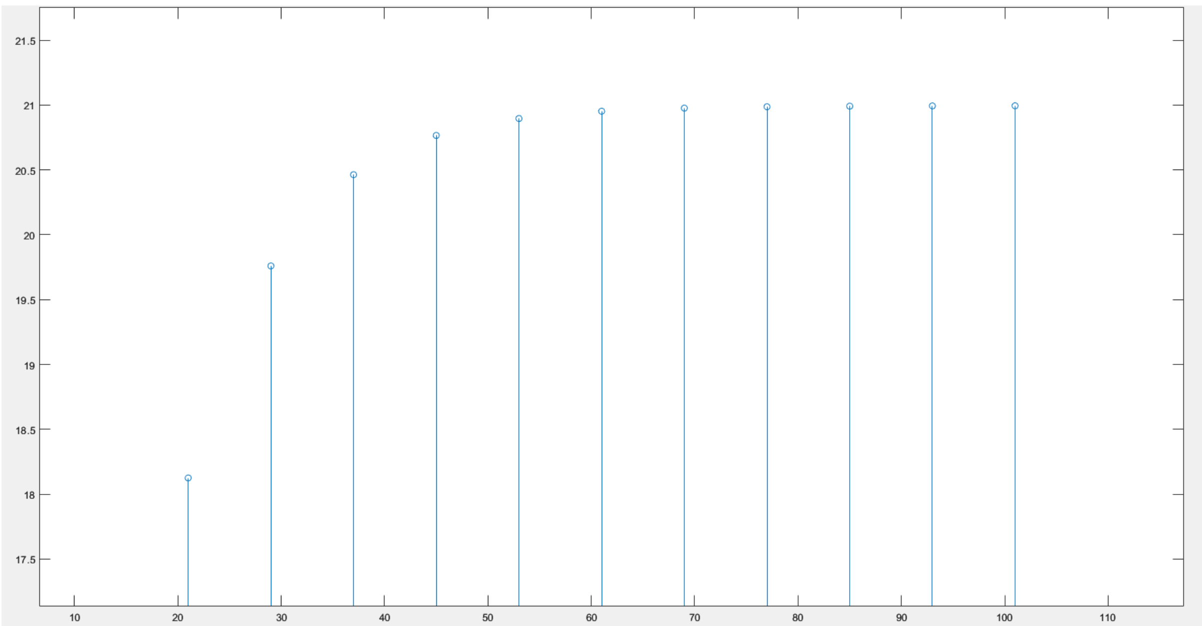
```
n=0:100;
n=n';
x(1)=0;
x(2)=0;
y(1)=0;
y(2)=0;
x(3:103)=cos(1/4*pi*n);
y(3:103)= zeros(101,1);
for n=0:100
    y(n+3)= 1.8*cos(pi/4).*y(n+2)-0.81*y(n+1) + x(n+3) - 2*cos(3*pi/4)*x(n+2) + x(n+1);
end

figure(4),stem(y);
```

For the graph:



The position of peaks for this phase response is around 21 when n>=0.



After plotting the sequence y[n] for n>=0, the sequence oscillates between -21 to 21with a frequency of pi/4

b)

Now assume $x[n] = \cos(\frac{\pi}{4}n)$ (without the step function $u[n]$). Compute and plot the output of the system, $y[n]$ for $n \geq 0$, using the following:

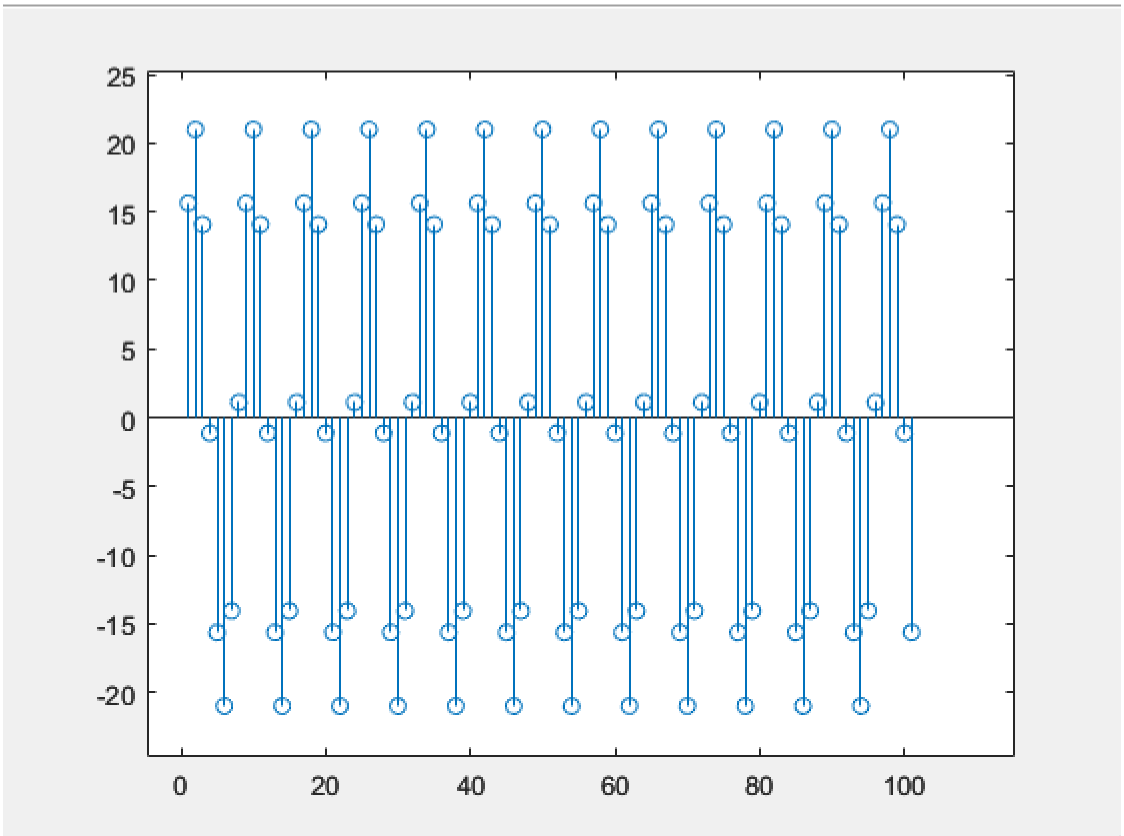
$$y[n] = |H(1/8)| \cos\left(\frac{\pi}{4}n + \angle H(1/8)\right). \tag{3}$$

Compare this with the above result. Are they close for large n? Do you know why?

For the coding part:

```
clear;
f=1/8;
x(1)=0;
x(2)=0;
y(1)=0;
y(2)=0;
y=zeros(101,1);
num= 1+sqrt(2).*exp(-1j*2*pi*f)+exp(-1j*2*pi*f*2);
den=1-0.9.*sqrt(2).*exp(-1j*2*pi*f)+0.81*(exp(-1j*2*pi*f*2));
H=num./den;
for n=1:101
    y(n)= abs(H).*cos((1/4*pi*n)+angle(H));
end
figure(4),stem(y);
```

For the graph:



Comparison:

The result should be close to each other as n gets larger and larger every time. As the observation by expanding y[n] to 1000 rows, and n from 1 to 1000, the result will get more closer to above result. In part a, the transfer function of the system has a magnitude equal to 21 when the f= pi/4. Compared to the result in b, the system has a magnitude is also pretty close to 21 as well

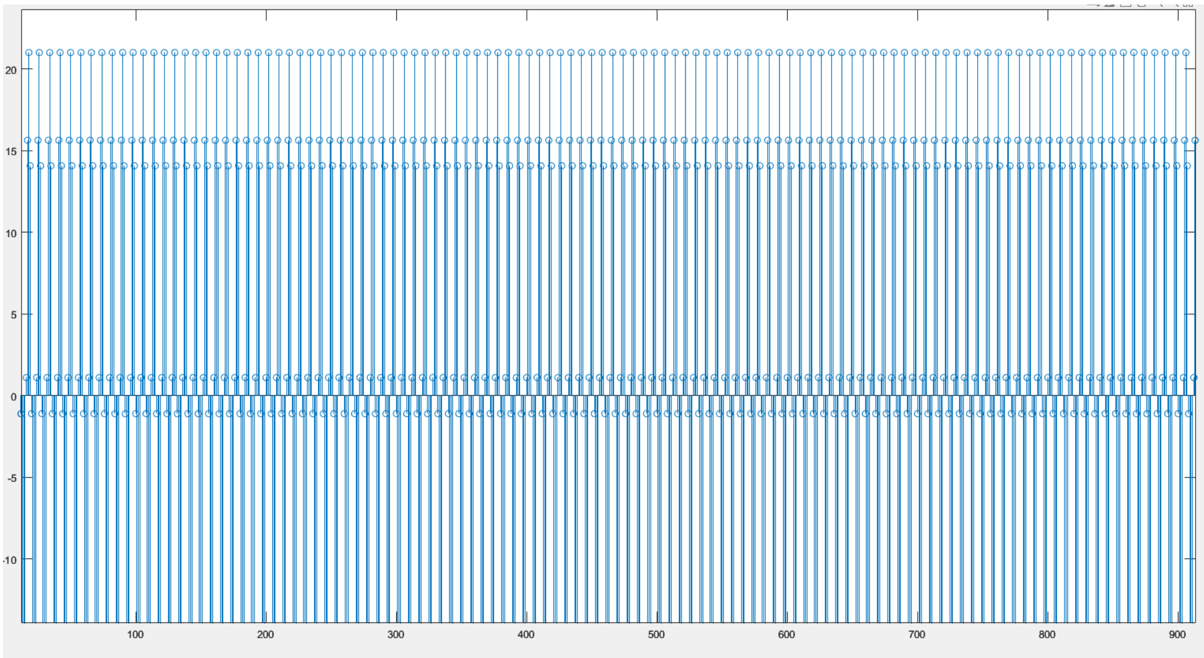
-> the output system is pretty close to the input signal with a phase angle of the transfer function.

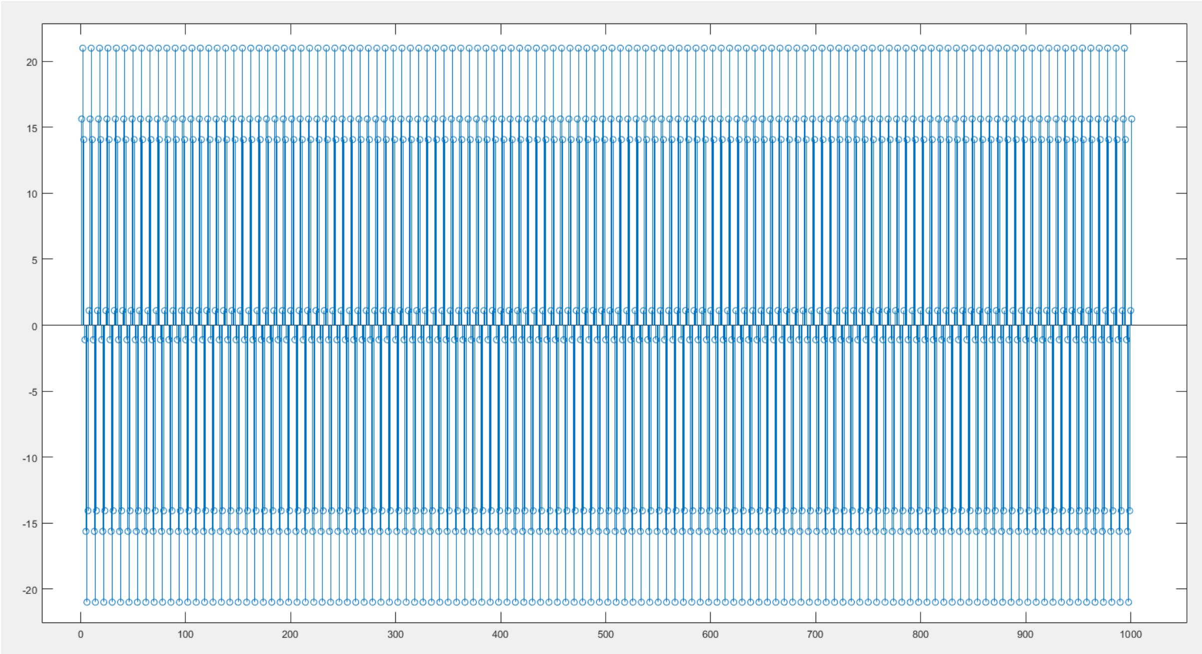
Testing with n range from 0 to 1000

For the coding part:

```
clear;
f=1/8;
x(1)=0;
x(2)=0;
y(1)=0;
y(2)=0;
y=zeros(1000,1);
num= 1+sqrt(2).*exp(-1j*2*pi*f)+exp(-1j*2*pi*f*2);
den=1-0.9.*sqrt(2).*exp(-1j*2*pi*f)+0.81*(exp(-1j*2*pi*f*2));
H=num./den;
for n=1:1001
    y(n)= abs(H).*cos((1/4*pi*n)+angle(H));
end
figure(4),stem(y);
```

For the graph part:




20
15
10
5
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-5
-10
-15
-20
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