# ADVANCED SIGNAL ANALYSIS AND PROCESSING LAB

**Lab sheet. No:** 02

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**Q1)** **Obtain the convolution of the given finite sequences**

**x1 =[4 2↑ 6 3 8 1 5]**

**x2 =[3 8 6↑ 9 6 7]**

**Note: arrow points to zero location in above sequences. Since MATLAB command does not give time index of the convolved result, derive it from the signals to be convolved.**

**AIM:** To find the convolution of 2 sequences.

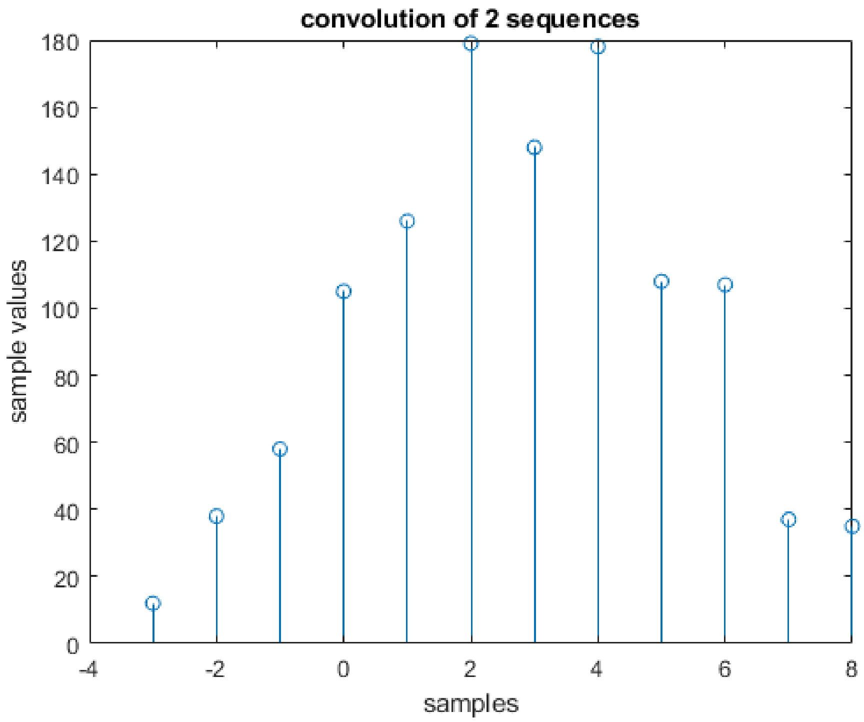
**Short Theory:** Convolution is a mathematical operation used to express the relation between input and output of an LTI system. It relates input, output and impulse response of an LTI system as

$$y(n)=x(n)*h(n)$$
$$=\sum_{-\infty}^{\infty}x(k)h(n-k)$$

**Key Commands:**

Conv %it convolves the 2 sequences

**Plots:**



## Inferences/comments:

Inbuilt command in MATLAB for convolution doesn't give the exact zero index of resultant sequence for the given input but still we can write the program in such a way that the resultant convolved sequence can plot the output sequence along with the exact index .

**Q2. Find the auto correlation and cross correlation of x1 and x2, with the help of convolution.**

**x1 =[4 2↑ 6 3 8 1 5]**
**x2 =[3 8 6↑ 9 6 7]**

**AIM:** To find the auto correlation and cross correlation 2 sequences.

**Short Theory:** Correlation is a measure of similarity between two signals.

Auto correlation function is a measure of similarity between a signal & its time delayed version.

$$Rx(n) = x(k)*x(-k) = \sum_{-\infty}^{\infty} x(k)x(n+k)$$

Cross correlation is the measure of similarity between two different signals.

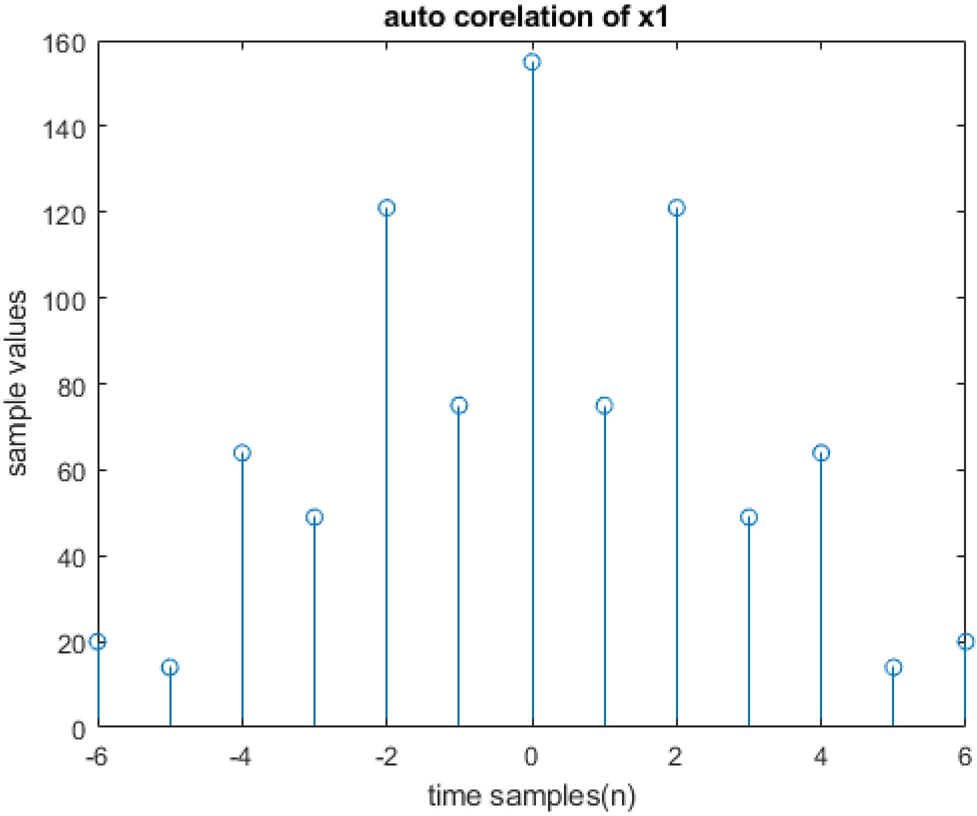
$$Rxy(n) = x(k)*y(-k) = \sum_{-\infty}^{\infty} x(k)y(n+k)$$

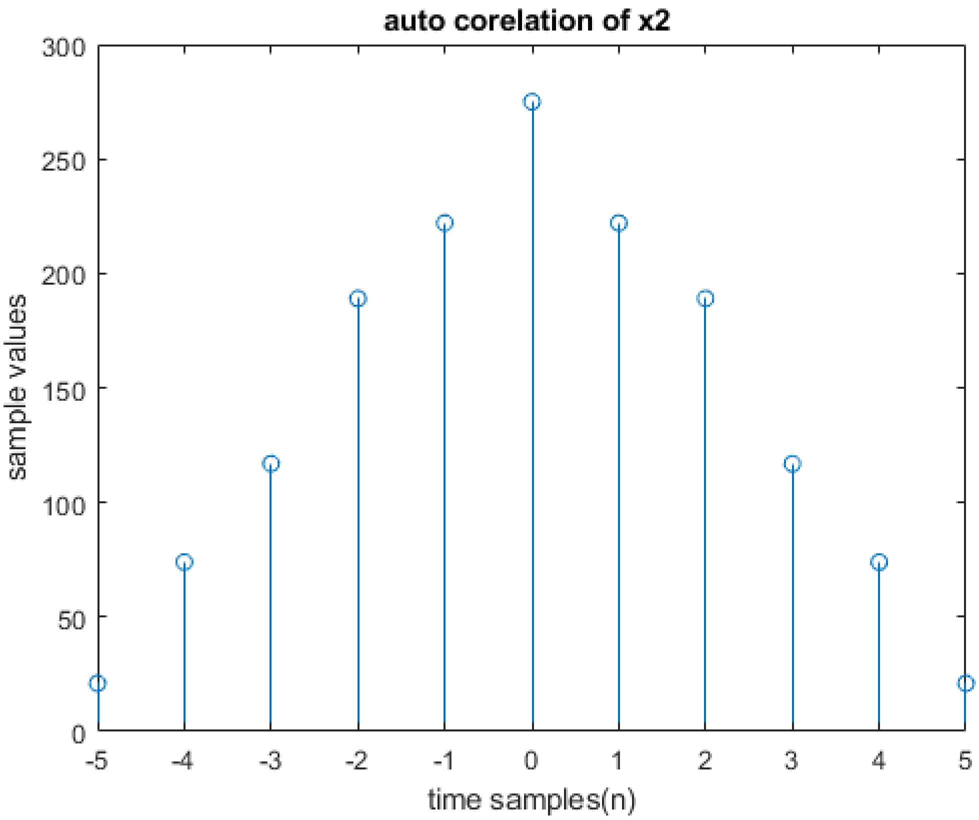
## Key Commands:

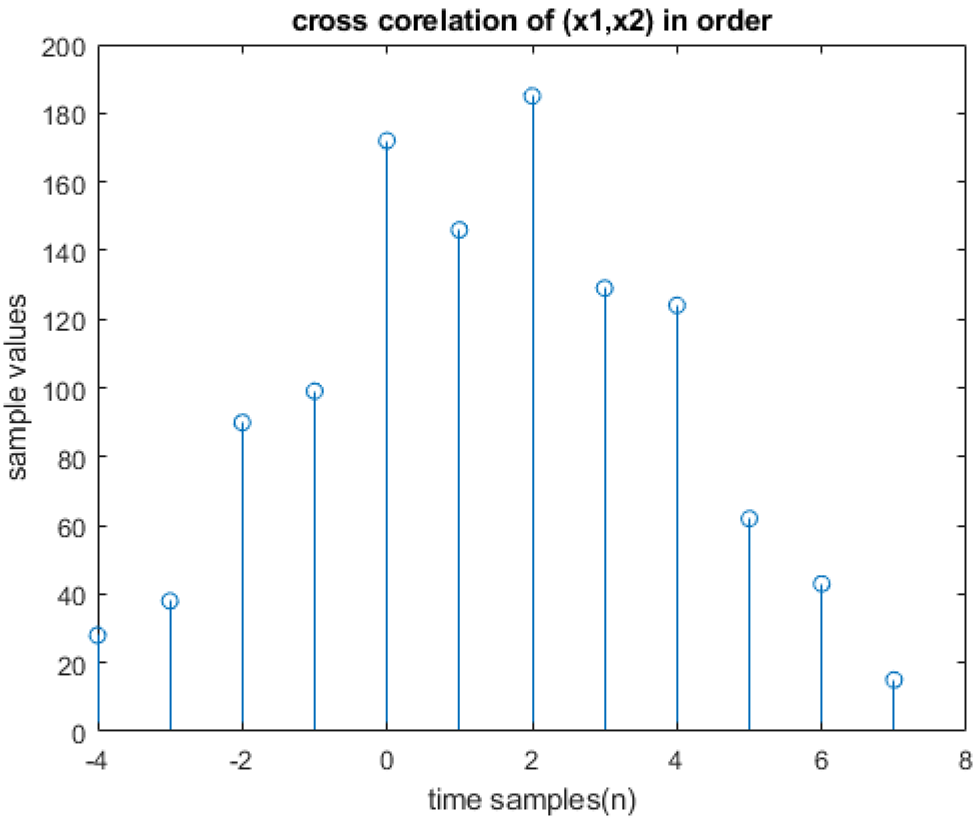
Conv % it convolve the 2 sequences

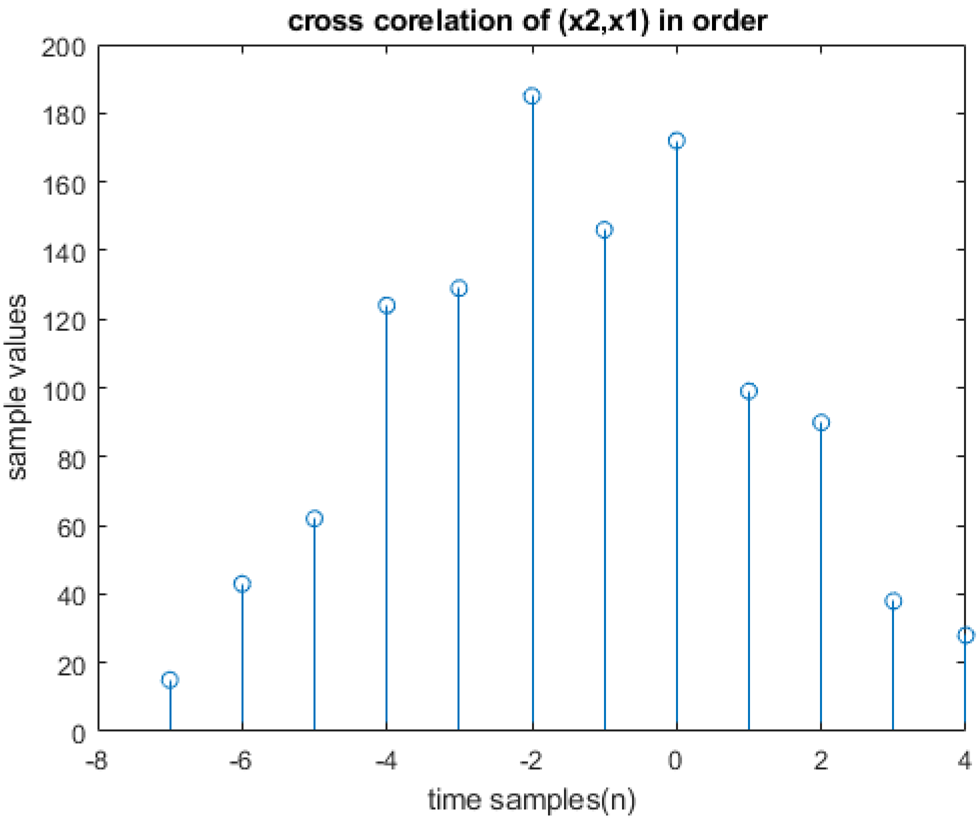
xcorr % it correlate the 2 signals

## Plots:


auto corelation of x1
sample values
time samples(n)
0
20
40
60
80
100
120
140
160
-6
-4
-2
0
2
4
6


auto corelation of x2
sample values
time samples(n)
0
50
100
150
200
250
300
-5
-4
-3
-2
-1
0
1
2
3
4
5




## Inferences/comments:

1)From the auto corelation plot we can clearly observe that the max value is occurs at n=0.

**3. exp(x) is the exponential of the elements of x (i.e., e^x). For complex number z=x+iy, exp(z) = exp(x)*(cos(y)+i*sin(y)). Taking appropriate values for z,**

**(a) generate and plot a complex-valued exponentially decaying sinusoidal sequence.**

**(b) generate and plot a complex-valued exponentially growing sinusoidal sequence using MATLAB.**

**AIM:** To find the exponential sequence of a complex number. And plot the decay/growing sinusoidal sequence by taking suitable example.

## Short Theory:

exp(x) is the exponential of the elements of x (i.e., e^x).

For complex number z=x+iy, $e^z = e^{\cos(y) + i * \sin(y)}$

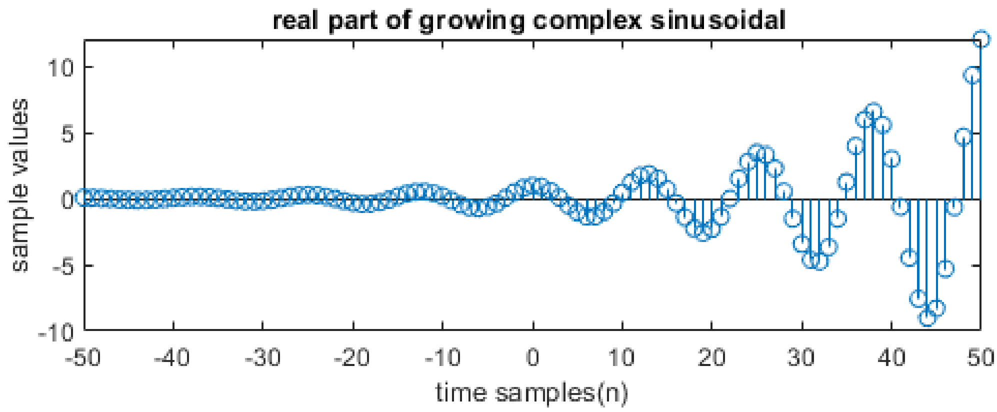
## Key Commands:

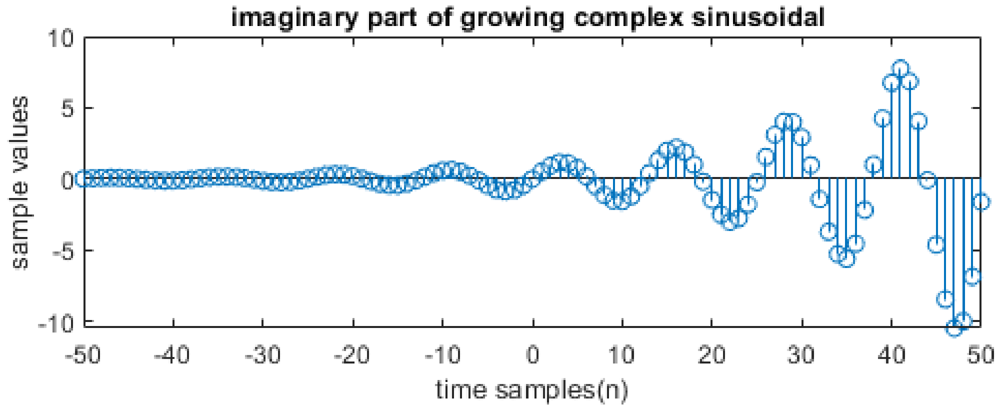
exp(x) %This command gives the exponential of x.

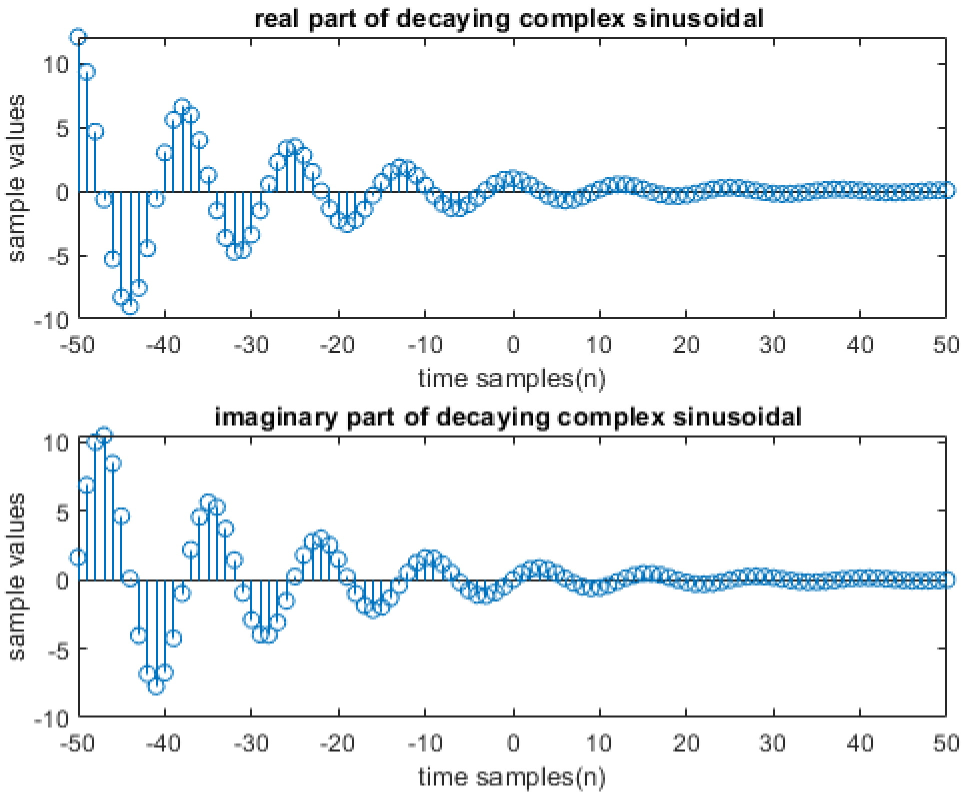
sin % it gives the values of sin(x)

cos % it gives the value of cos(x)

## Plots:






## Inferences/comments:

Let complex number Z=a+jb , then if a<0 then it will gives the decaying sinusoidal, if a>0 then it gives growing sinusoidal.

**Q4. Find solution for y[n] from difference equation y[n] = ay[n−1]+x[n], with x[n] = δ[n] and simulate it using "filter" command. Can you relate it to any of the standard signals? assume the initial conditions are zeros.**

**AIM:** To solve the differential equation y[n] = ay[n−1]+x[n], by taking different values of 'a'.

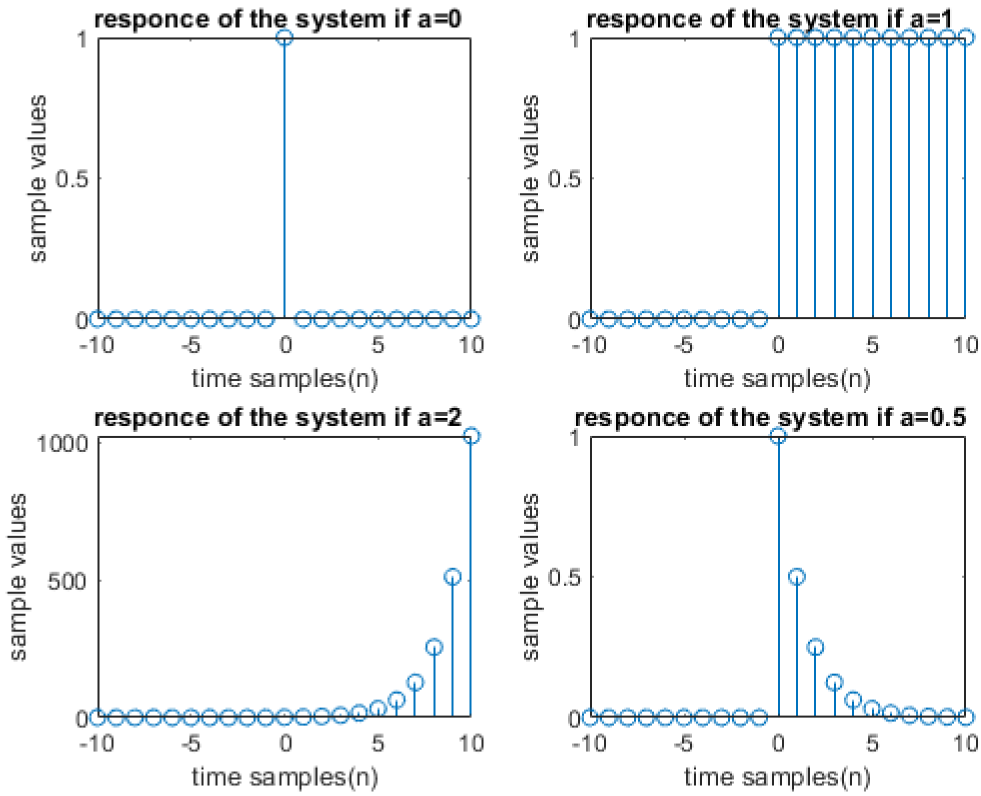
## Short Theory:

The solution of a differential equation y[n] can be obtained by converting given differential equation into transfer function (h[n]=y[n]/x[n]). Then multiplying the h[n] with the given input signal x[n] .

## Key Commands:

Filter % filter(b,a,x) filters the input data x using a rational transfer function defined by the numerator and denominator coefficients b and a

## Plots:




## Inferences/comments:

**1)**if we take a=0, the output plot as unit impulse signal,

2)if we take a=1, the output plot as unit step signal.

3)if we take a=2 the output plot as growing exponential signal.

4)if we take a=0.5, the output plot as decaying exponential signal

**Q5. Generate complex exponential signal as impulse response to the following difference equation: with initial conditions are zero.**

**y[n] = z0y[n − 1] + x[n], where, z0 = 0.8e^(jπ/3).**

**AIM:** To generate and plot the complex exponential sequence from the differential equation.

**Short Theory:** The solution of a differential equation y[n] can be obtained by converting given differential equation into transfer function (h[n]=y[n]/x[n]). Then multiplying the h[n] with the given input signal x[n] .

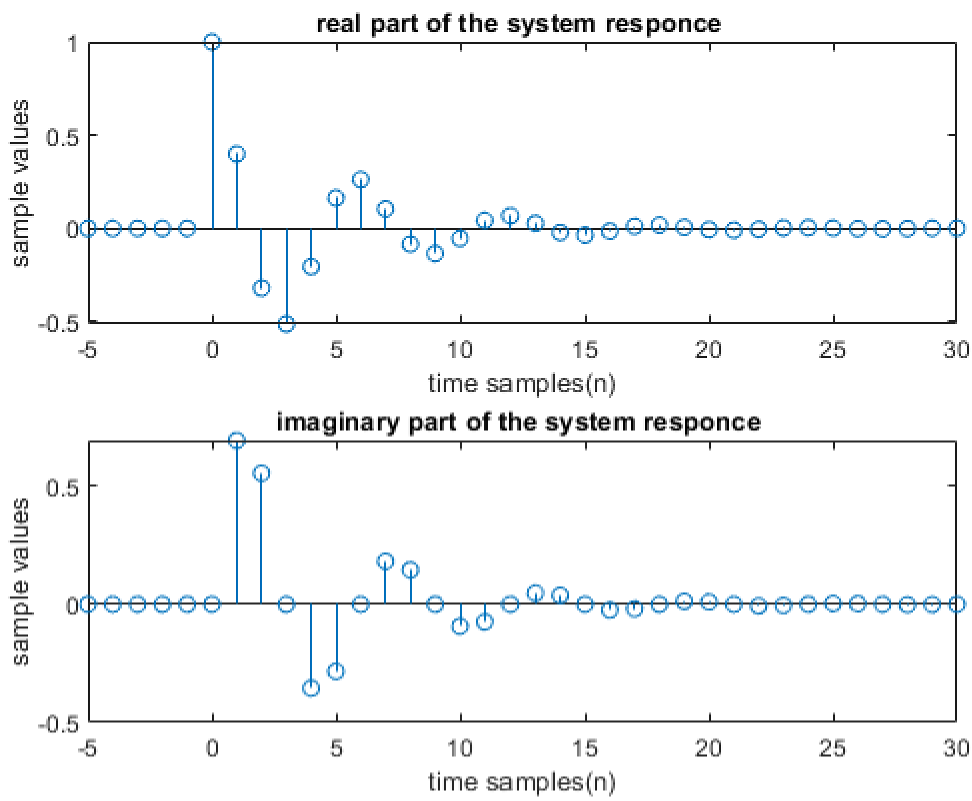
## Key Commands:

Real % it gives the real part of the signal

Imag % it gives the imaginary part of the signal

Filter % filter(b,a,x) filters the input data x using a rational transfer function defined by the numerator and denominator coefficients b and a

## Plots:



## Inferences/comments:

We can observe that for a complex coefficients the output response is a sinusoidal response, where as if the coefficient is real, it will give different signal for different coefficients.

**Q6. Use "filter" function to generate and plot the impulse response h[n] of the following difference equation. Plot h[n] in the range $-10 <= n <= 100$. assume the initial conditions are zeros**

$$y[n] - 1.8\cos(\pi/16)y[n-1] + 0.81y[n-2] = x[n] + 0.5x[n-1]$$

**AIM:** To generate and plot the impulse response h[n] of the following difference equation in the range −10 to 100.

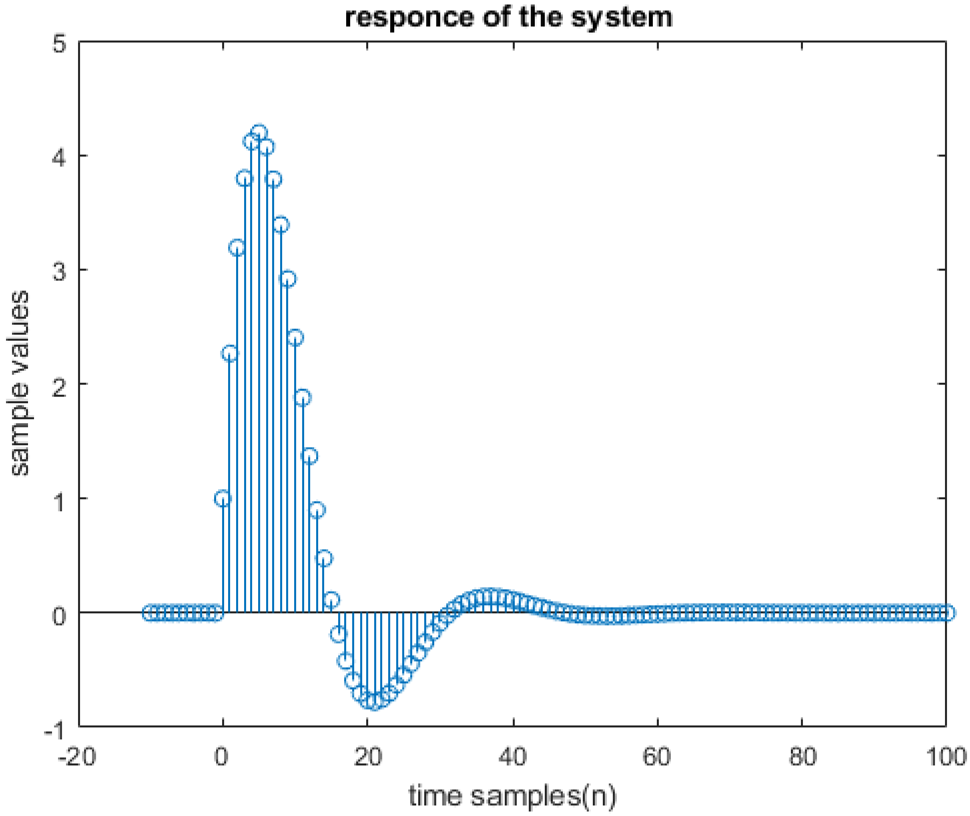
## Short Theory:

The solution of a differential equation y[n] can be obtained by converting given differential equation into transfer function (h[n]=y[n]/x[n]). Then multiplying the h[n] with the given input signal x[n] .

## Key Commands:

Filter % filter(b,a,x) filters the input data x using a rational transfer function defined by the numerator and denominator coefficients b and a

## Plots:




## Inferences/comments:

The output response of the given signal is a decaying sinusoidal signal.