ADVANCED SIGNAL ANALYSIS AND PROCESSING LAB

Lab sheet. No: 01

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Q1. Generate standard signals with a single MATLAB command: Use "stem" command to plot them and label and mark values on x- and y- axis.

a) unit impulse signal with x-axis range -10 to 10

b) unit step signal with x-axis range -10 to 10

c) ramp signal with x-axis range 0 to 10

d) real exponential signal with a = 0.9 and x-axis range 0 to 10

AIM:-

To Generate unit impulse signal , unit step signal , ramp signal ,real exponential signal with a single MATLAB command "stem".

Short Theory:

unit impulse signal is zero everywhere but at the origin is 1.

unit step signal is 1 from zero to infinity.

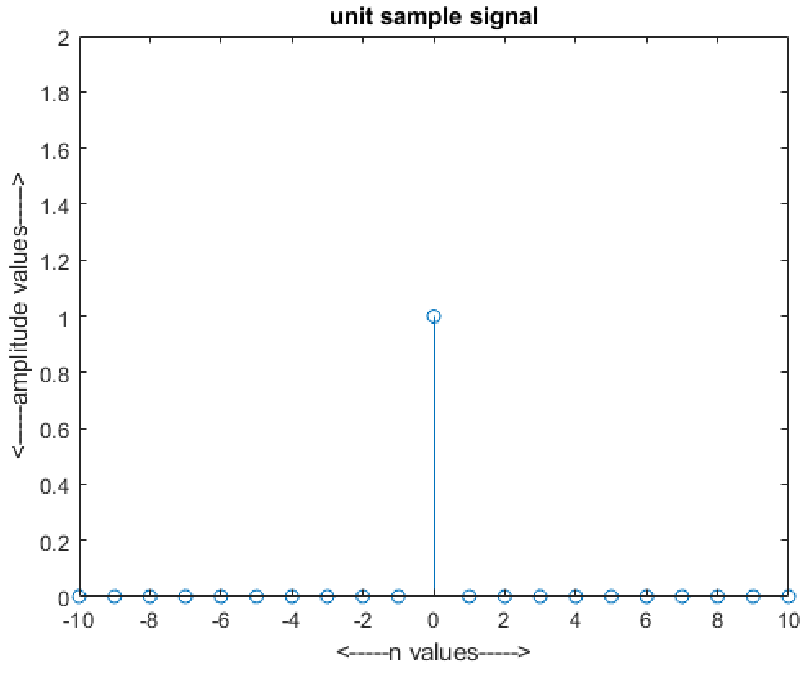
ramp signal is defined for r(n)={n, for n≥0

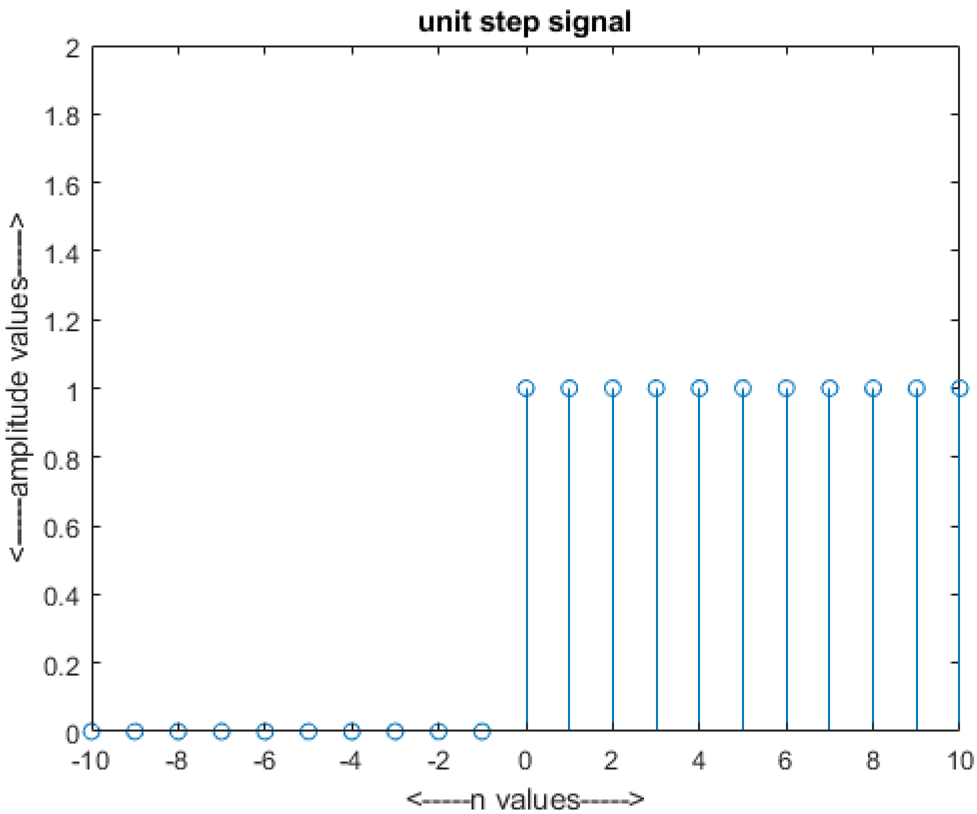
0, for n<0}

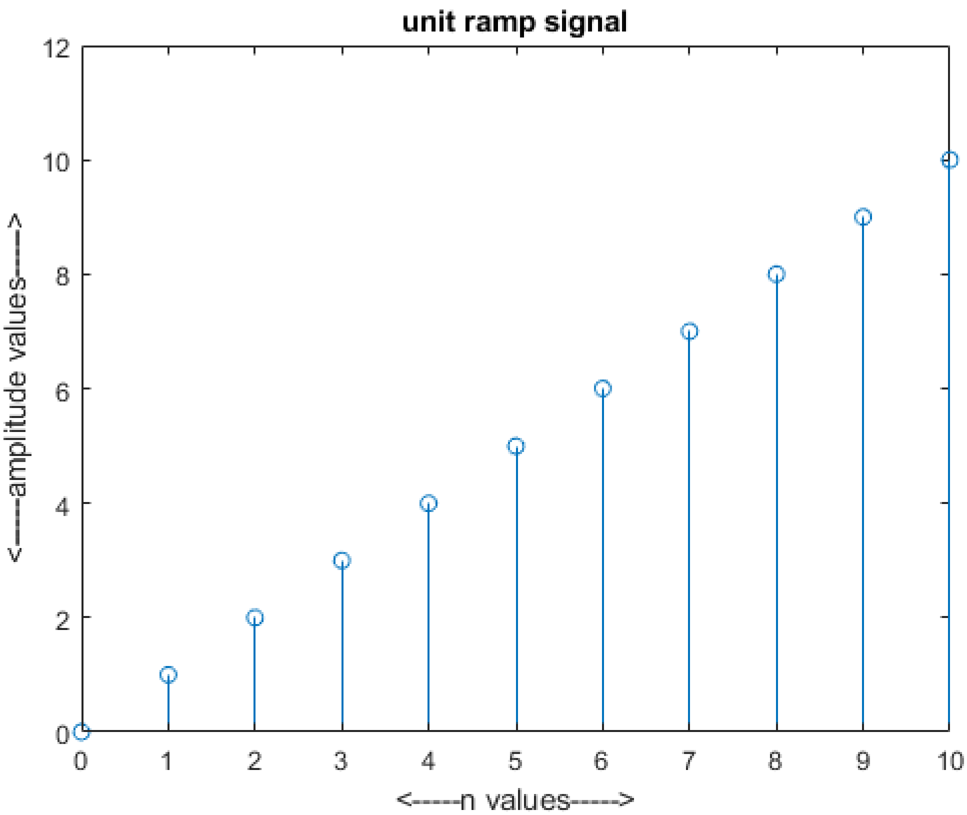
Key Commands:

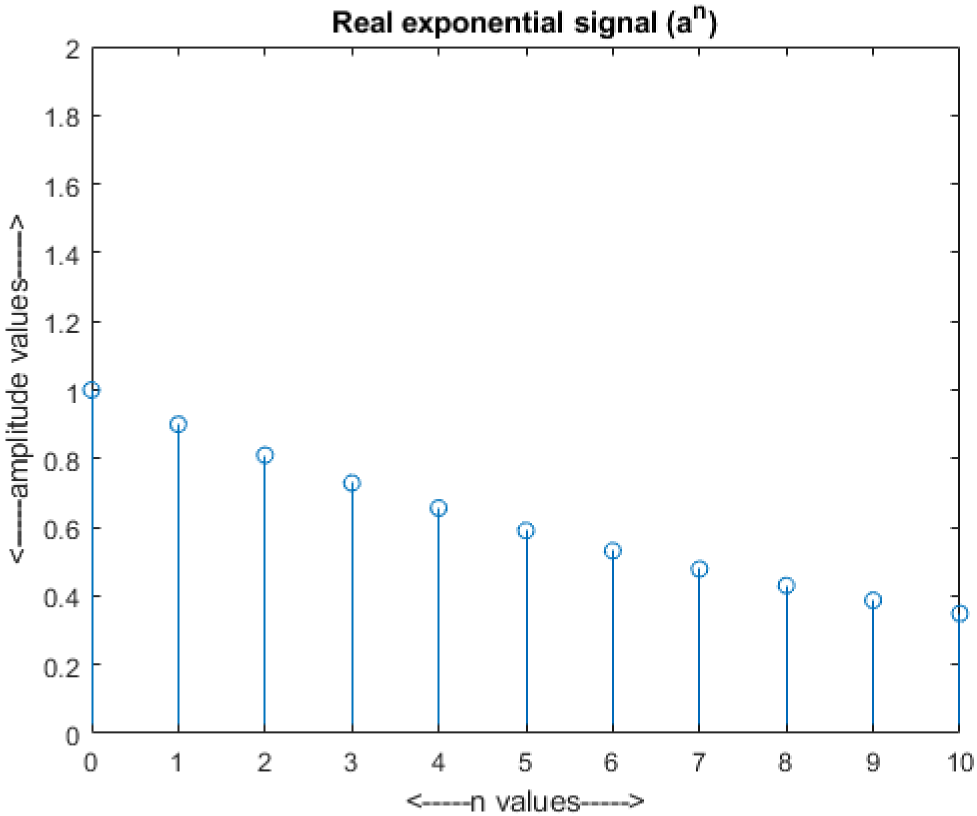
Stem % stem(**X , Y**) plots the data sequence, Y , at values specified by X .

Plots:




unit step signal
<-----amplitude values----->
<-----n values----->


unit ramp signal
<-----amplitude values----->
<-----n values----->



Inferences/comments:

By using stem command we can generate unit impulse signal , unit step signal , ramp signal, exponential signal in MATLAB.

Q2. Generate and plot the following sinusoidal signals by exploring the MATLAB vector handling capability

a) x[n] = 3sin(2πn+π/3) for -10<= n <= 10

b) x[n] = 5cos(2πn/3+π/4) + 2.5sin(πn/3+π/4) for -10<= n <= 10

AIM:-

To generate the sinusoidal signals by taking the inputs as amplitude, number of samples, phase shift.

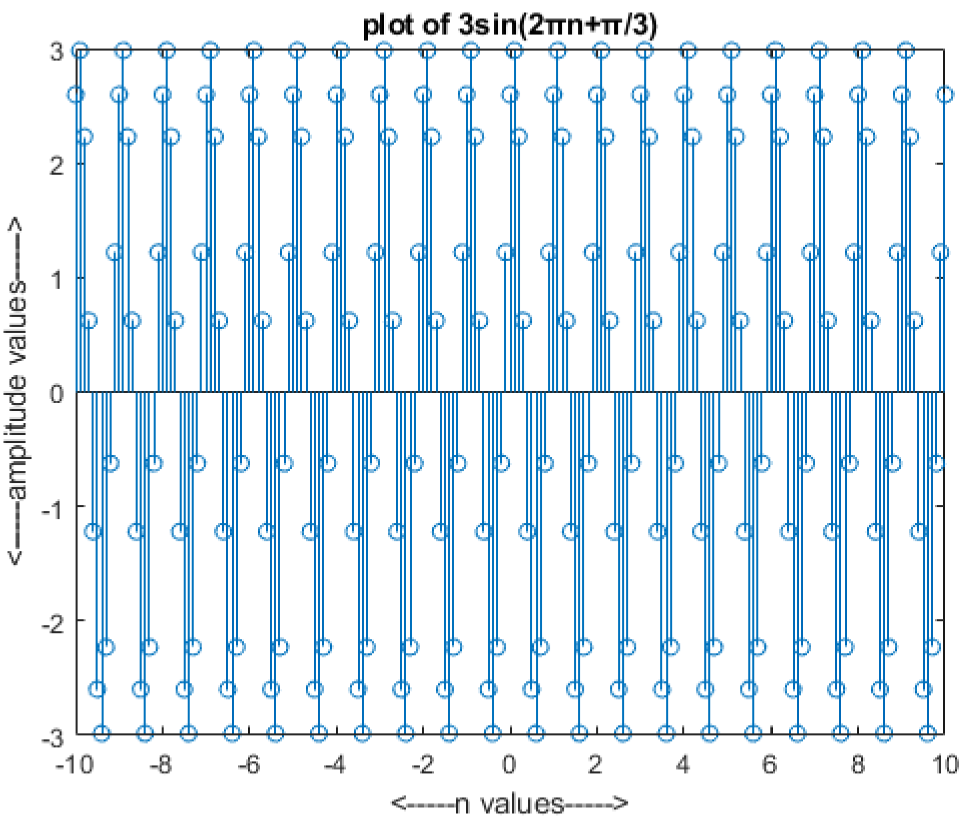
Short Theory:

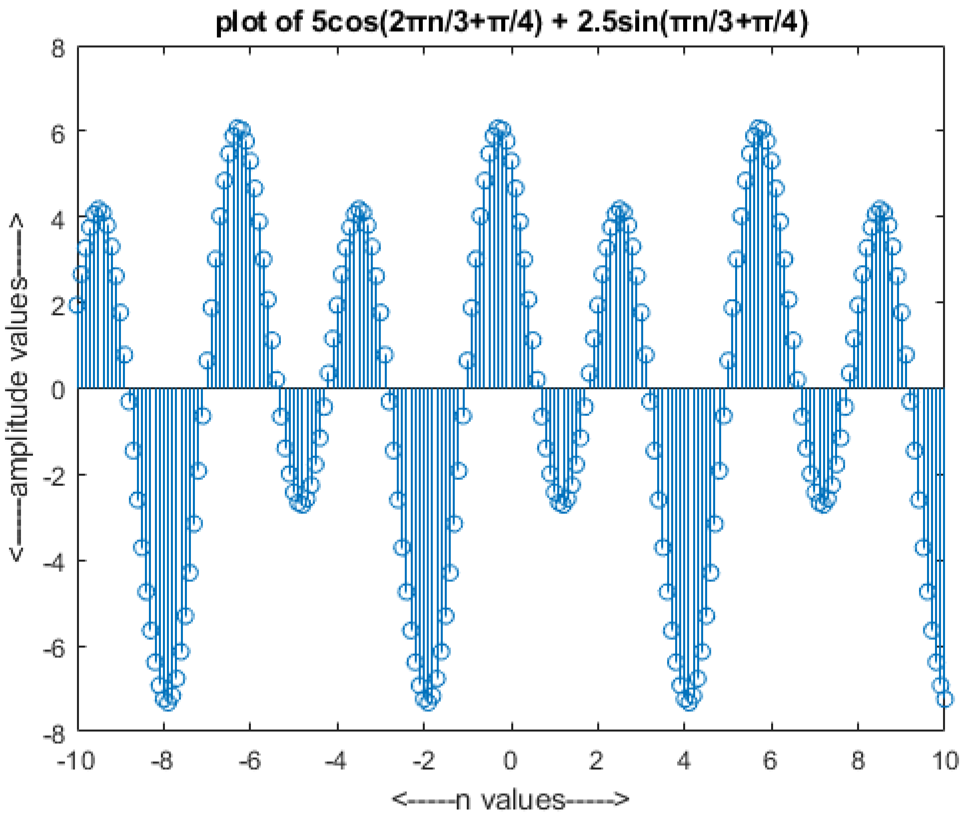
Y = sin(X) returns the sine of the elements of X, The sin function operates element-wise on arrays. The function accepts both real and complex inputs and by using the stem command we can plot the returned sin values.

Key Commands:

1)sin(x) %this command gives the values of sin(x)
2)stem % stem(**X , Y**) plots the data sequence, Y , at values specified by X .

Plots:





Inferences/comments:

By using MATLAB, We can we can generate sinusoidal signals different frequency, amplitude, and phase. We can also perform addition of different sinusoidal signals.

Q3. In signal processing it is often needed to find the sum of exponential sequence x[n] = a^n u[n]. Find this sum over 0 to 100 for a = 0.9 and verify it by analytically determining the same.

AIM:-

To find the sum of real exponential sequence (x[n]=a^n) over 0 to 100 by taking a=0.9
And verify it by analytically.

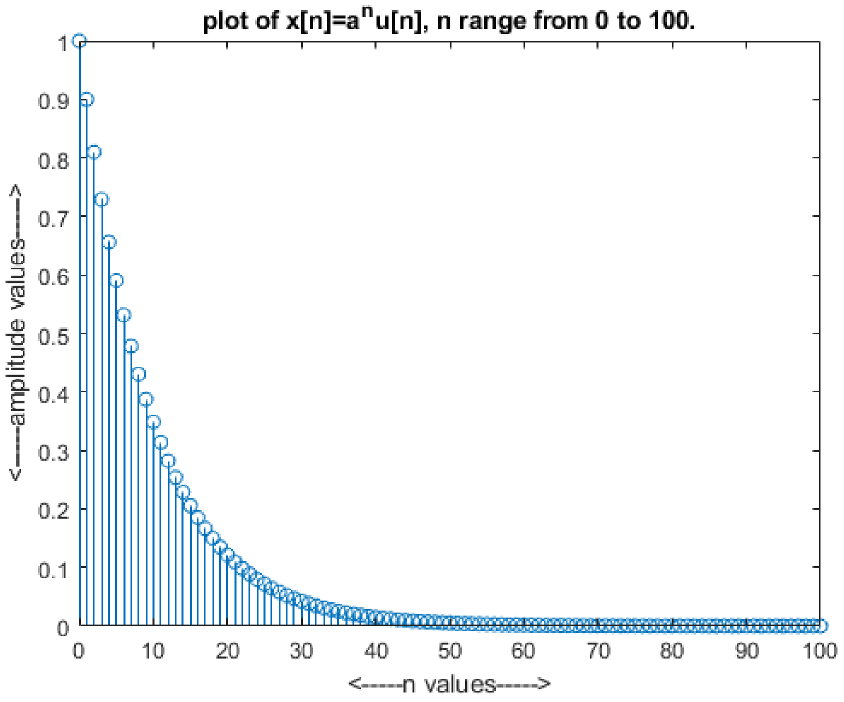
Short Theory:

sum(x) returns the sum of the elements of x along the first array dimension whose size does not equal 1. If x is a vector, then sum(x) returns the sum of the elements. If A is a matrix, then sum(x) returns a row vector containing the sum of each column.

Key Commands:

Sum % if x is a vector then sum(x) gives the sum of all the elements of x.
Disp % disp(a) ,it display the values of a.
display

Plots:



Inferences/comments:

By using sum command we can easily find the sum of the any length of given exponential series.by using display command we can display the Result.

Q4. In signal processing, it is often needed to deal with complex exponentials.

a) Plot real and imaginary parts of complex exponential signal:

y[n] = r^n exp(jπn/3), where r = 0.8; (and r = 1.2) and 0<= n <= 20.

b) Plot magnitude and phase signals of the above complex exponential using appropriate MATLAB functions

AIM:-

To generate the real and imaginary parts AND magnitude and phase signals of complex exponential signal y[n] = r^n exp(jπn/3), and plot them for given r=0.8 and range 0 to 20.

Short Theory:

A signal whose samples are complex numbers, where the real and imaginary parts of the samples form, respectively, a cosine wave and a sine wave, both with the same frequency $Ae^{-i\omega t}$ = A(cosω n + i sinω n)

Key Commands:

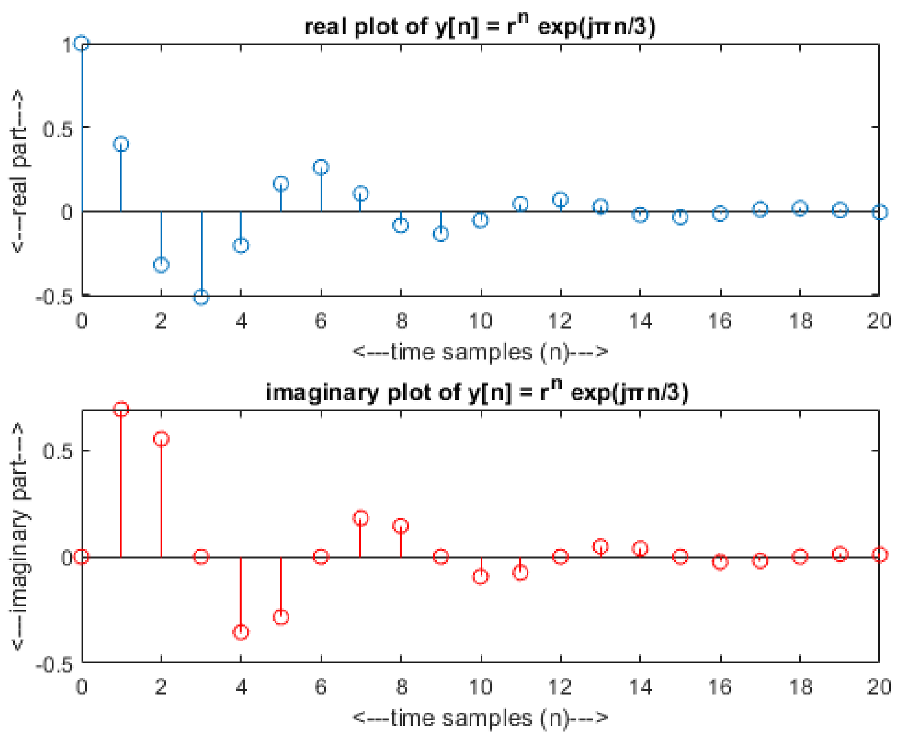
Real %if x is a signal, real(x) gives the real part of the signal.

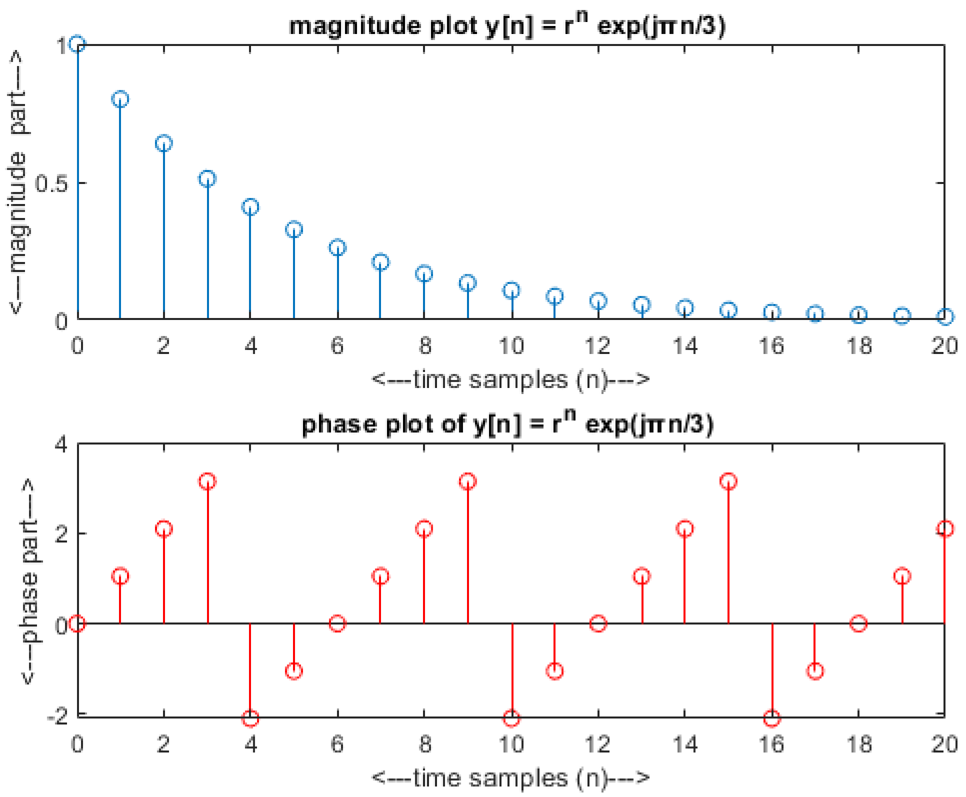
Imag % if x is a signal, imag(x) gives the imaginary part of the signal x.

Abs % if x is a signal, abs(x) gives the magnitude/absolute value of the signal.

Angle % if x is a signal, angle(x) gives the phase of the signal.

Plots:





Inferences/comments:

For a given complex signal, we can extract the real and imaginary paerts of the signal, and also we can re construct the complex signal by real part+j*imag part.

Q5. Impulse and Step Sequences

a) **Generate and plot a unit sample sequence for n = -10 to 20 (Program P1),**

b) **Modify Program P1 to generate a delayed unit sample sequence with a delay of 11 samples.**

c) **Modify Program P1 to generate a unit step sequence s[n].**

d) **Modify Program P1 to generate advanced unit step sequence with an advance of 7 samples.**

AIM:-

To generate and plot the Impulse and Step Sequences for given range of samples n=-10 to 20. And generate the unit sample and unit step sequence by giving delay and advance of 11,7 samples respectively.

Short Theory:

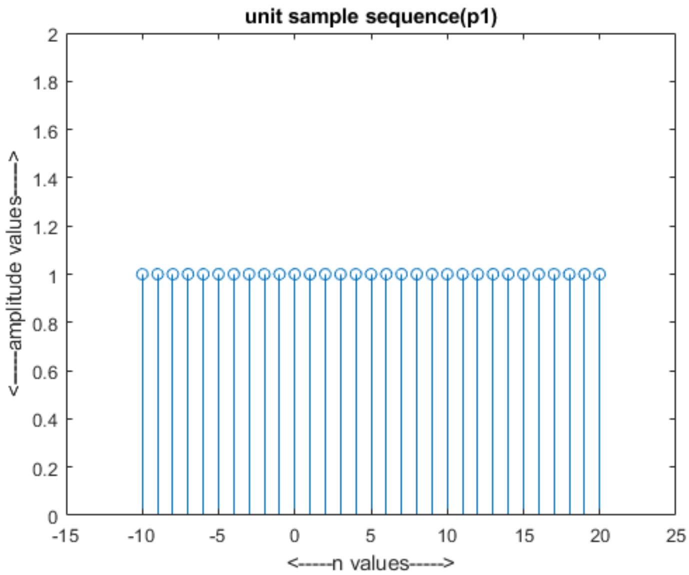
Unit sample sequence from n=-10 to 20 having a value 1 for $-10 \leq n \leq 20$ remaining all zero. unit step signal is 1 from zero to infinity.

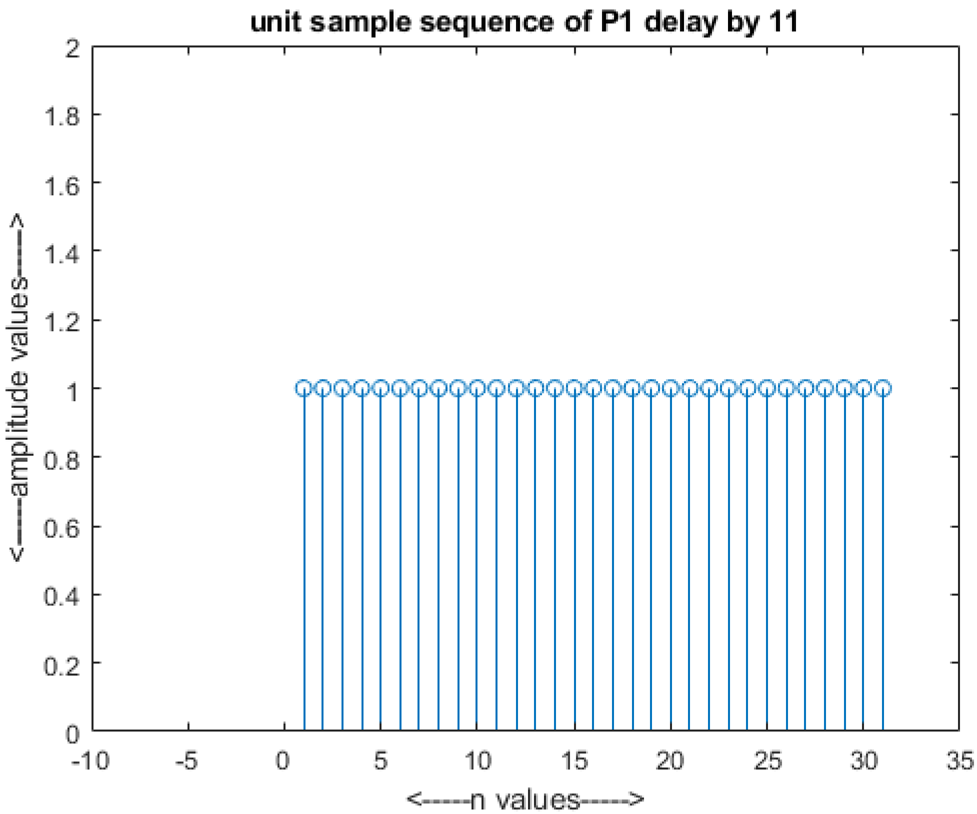
Key Commands:

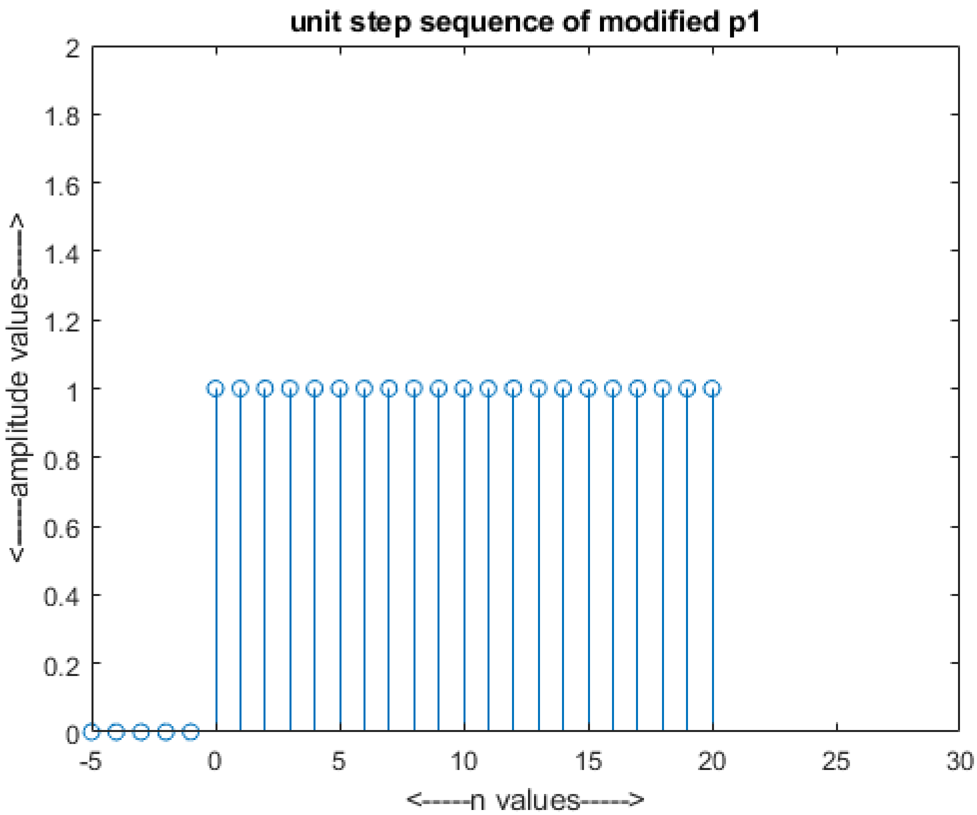
stem % stem(X , Y) plots the data sequence, Y , at values specified by X .

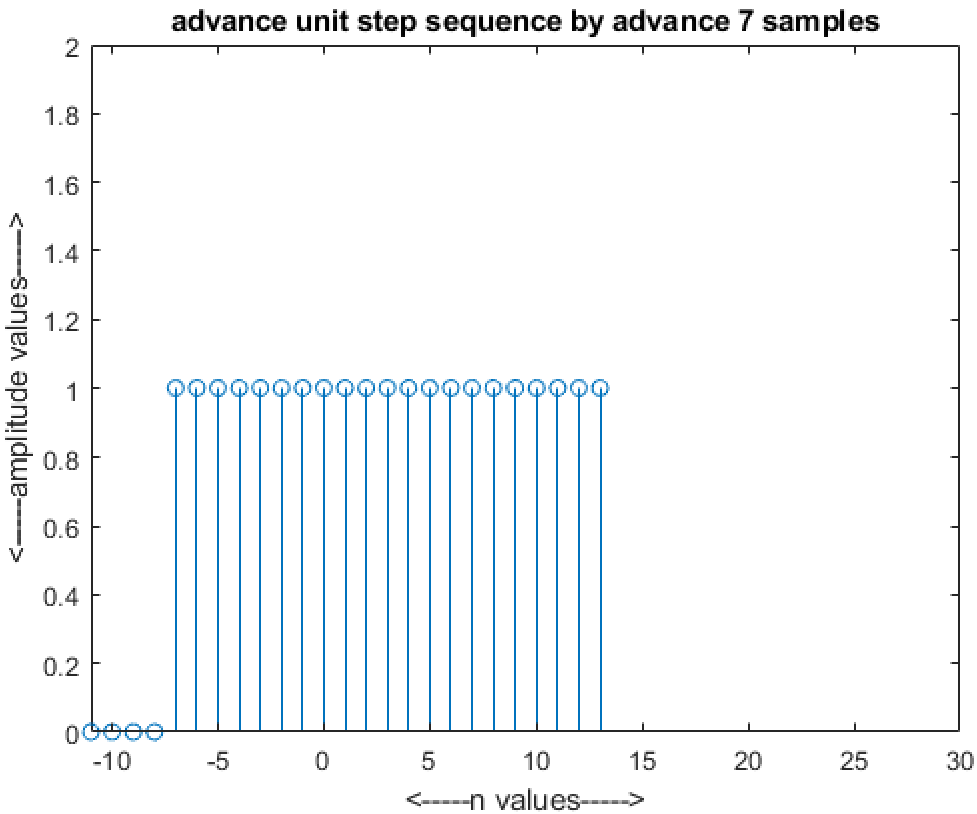
axis % axis command specifies the limits for the current axes.

Plots:




unit sample sequence of P1 delay by 11
<-----amplitude values----->
<-----n values----->
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-10
-5
0
5
10
15
20
25
30
35


unit step sequence of modified p1
<-----amplitude values----->
<-----n values----->
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-5
0
5
10
15
20
25
30



Inferences/comments:

If the signal range is from X to Y ,we delay/advance the samples by t units, then the signal range will be shifted to X ± t to Y ± t.

Q6. Sinusoidal Sequences

a) **write a program to generate a sinusoidal sequence of length 50, frequency 0.08, amplitude 2.5, and phase shift 90 degrees and display it.**

b) **Given two sinusoids with the following amplitude and phases:**

$x1(t) = 5 \cos(2 \pi *500t)$

$x2(t) = 5 \cos(2 \pi *1200 t + 0.25 \pi)$

Create a MATLAB program to sample each sinusoid and generate a sum of sinusoids, that is, x(n) = x1(n) + x2(n) using a sampling rate of 8000 Hz and plot the sum x(n) over a range of time that will exhibit approximately 0.025 second.

AIM:-

To generate and plot the sinusoidal sequence of length 50 for a given specifications, f=0.008,A=2.5, φ=90 degrees And to generate the sinusoidal signal by adding different 2 sinusoidal signal for required length of sequence.

Short Theory:

A sinusoidal sequence is the fundamental periodic signal having just one single frequency.
In MATLAB Y = sin(X) returns the sine of the elements of X, The sin function operates element-wise on arrays. The function accepts both real and complex inputs and by using the stem command we can plot the returned sin values.

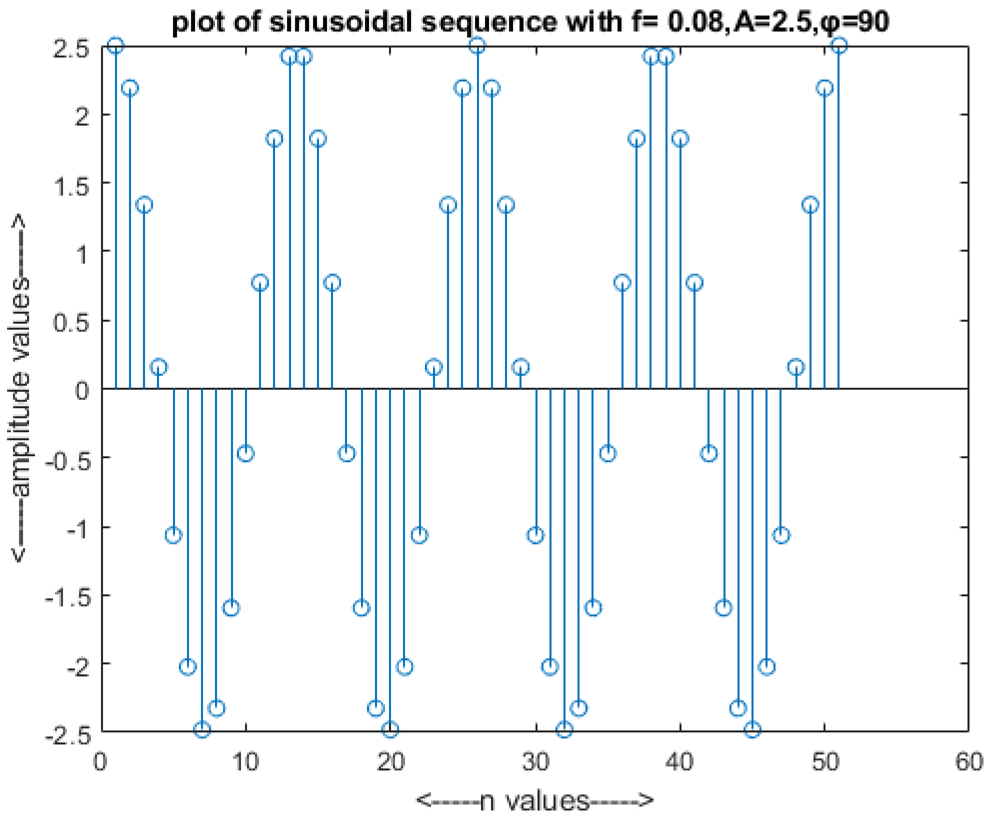
Key Commands:

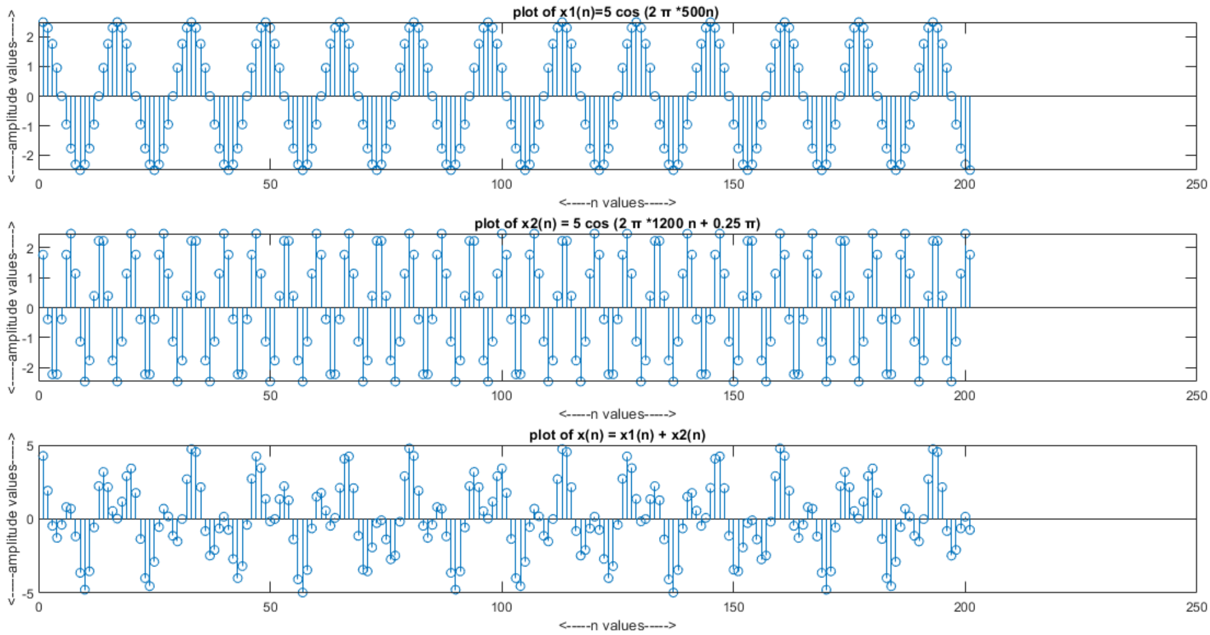
Cos(x) %this command gives the values of sin(x)

Sin(x) %this command gives the values of sin(x)

stem % stem(X , Y) plots the data sequence, Y , at values specified by X .

Plots:





Inferences/comments:

Higher the continuous frequency, lesser the fundamental period N,

For X1[n] signal, the fundamental period N=16,

For X2[n] signal, the fundamental period N=13,

Q7. Generation of Random Signals:

a) **Write a MATLAB program to generate and display a random signal of length 100 whose elements are uniformly distributed in the interval [−2, 2].**

b) **Write a MATLAB program to generate and display a Gaussian random signal of length 75 whose elements are normally distributed with zero mean and a variance of 3.**

c) **Write a MATLAB program to generate and display five sample sequences of a random sinusoidal signal of length 31 $\{X[n]\} = \{A. \cos(\omega o n + \varphi)\}$ where the amplitude A and the phase φ are statistically independent random variables with uniform probability distribution in the range $0 \le A \le 4$ for the amplitude and in the range $0 \le \varphi \le 2\pi$ for the phase.**

AIM:-

To generate and plot the uniformly distributed random variables, normally distributed random variables with given mean and a variance for a given sequence length

Short Theory:

The uniform distribution is a continuous probability distribution and is concerned with events that are equally likely to occur.

Normal Distribution is a probability distribution where probability of x is highest at centre and lowest in the ends whereas in Uniform Distribution probability of x is constant.

Key Commands:

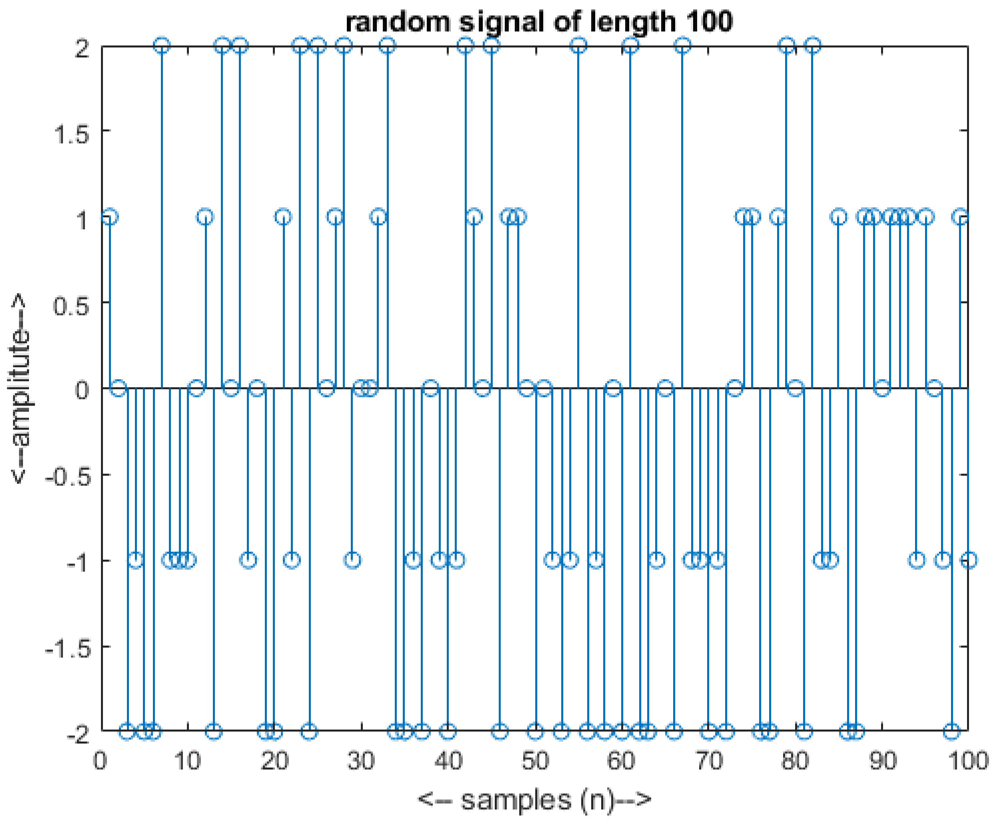
randi % it generates the uniform distributed random numbers

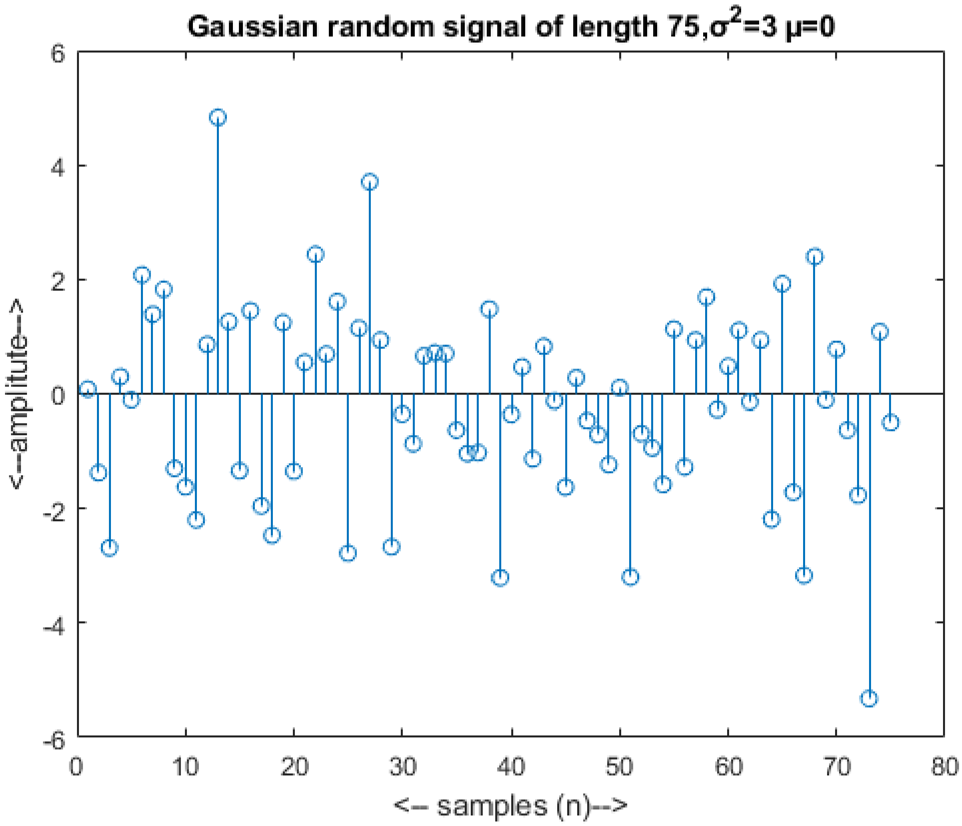
randn % it generates the gaussian random numbers.

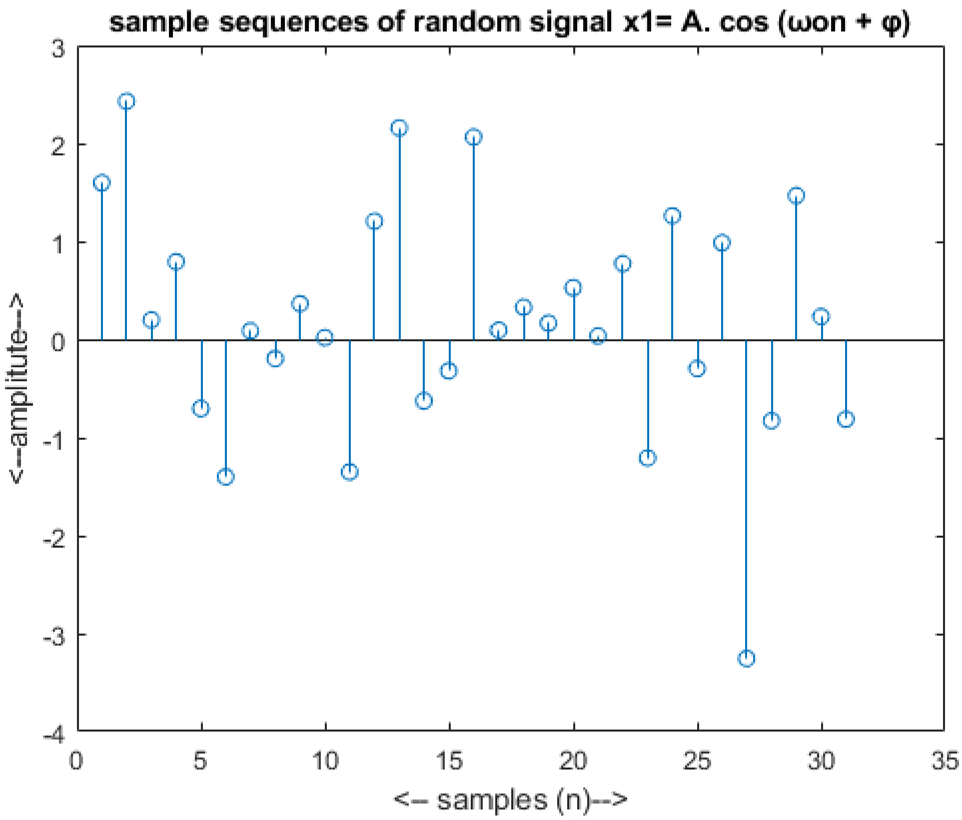
cos(x) % this command gives the values of cos(x)

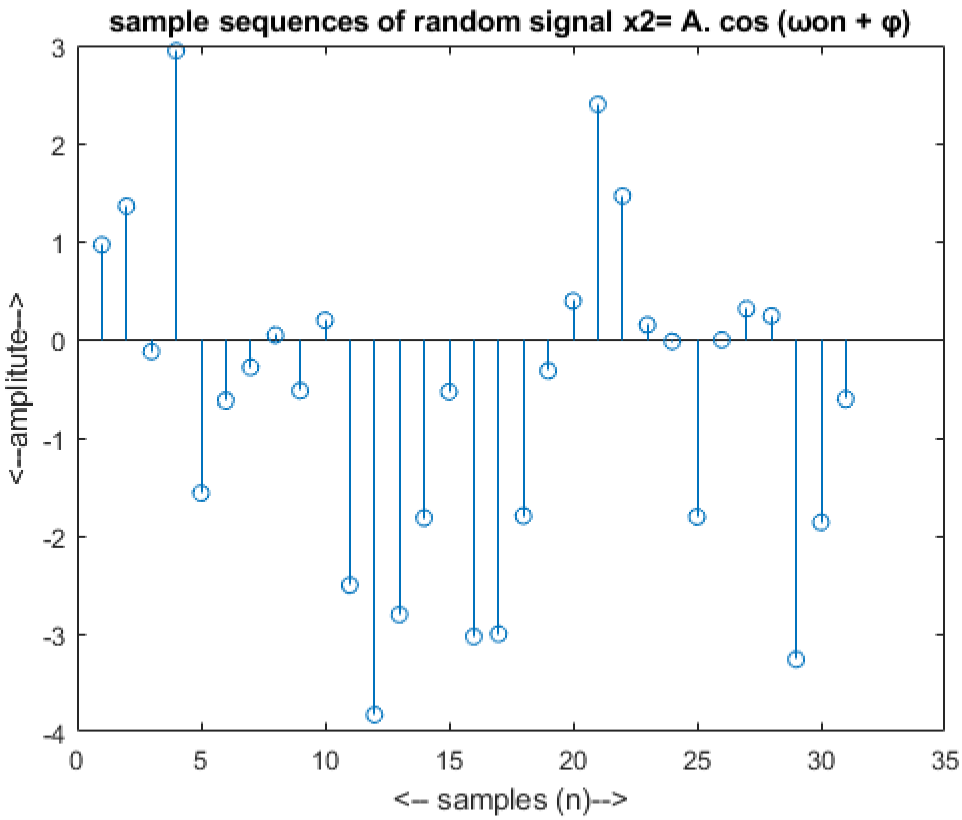
stem % stem(X , Y) plots the data sequence, Y , at values specified by X .

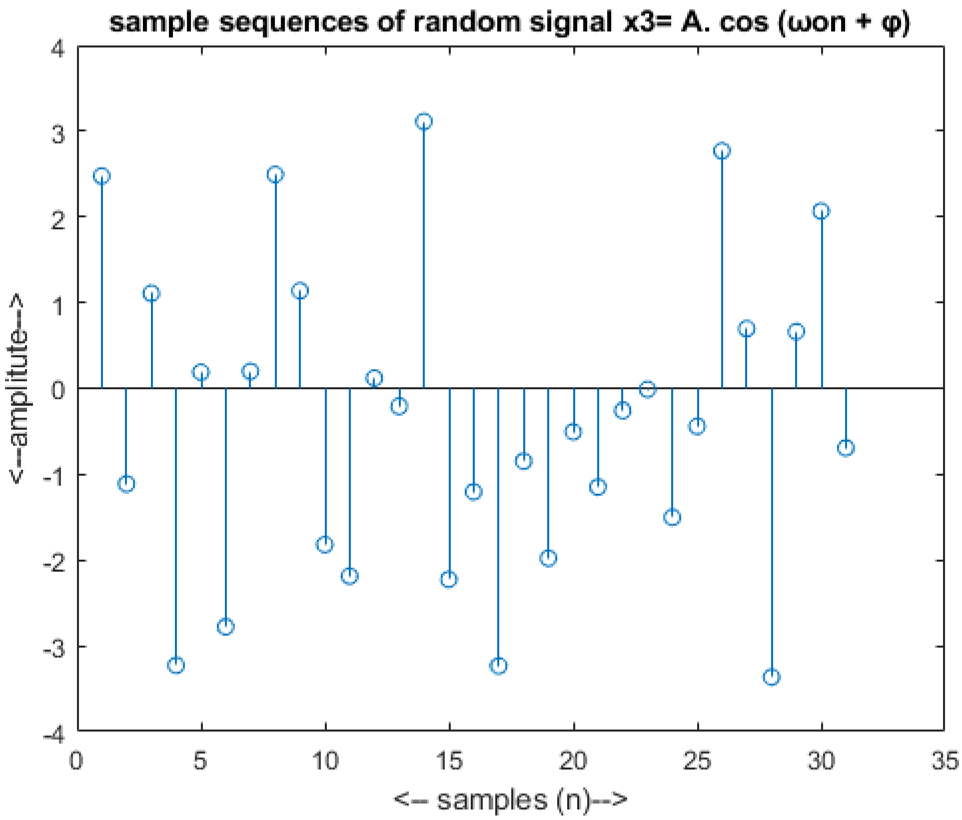
Plots:

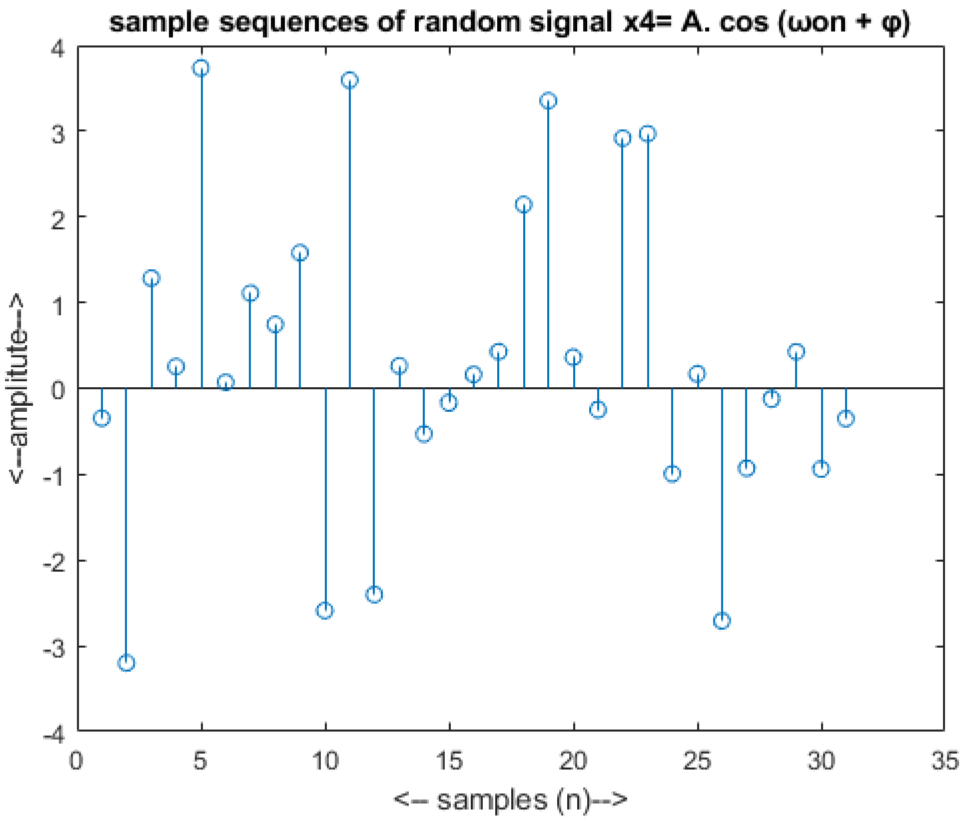

random signal of length 100
<--amplitute-->
<-- samples (n)-->

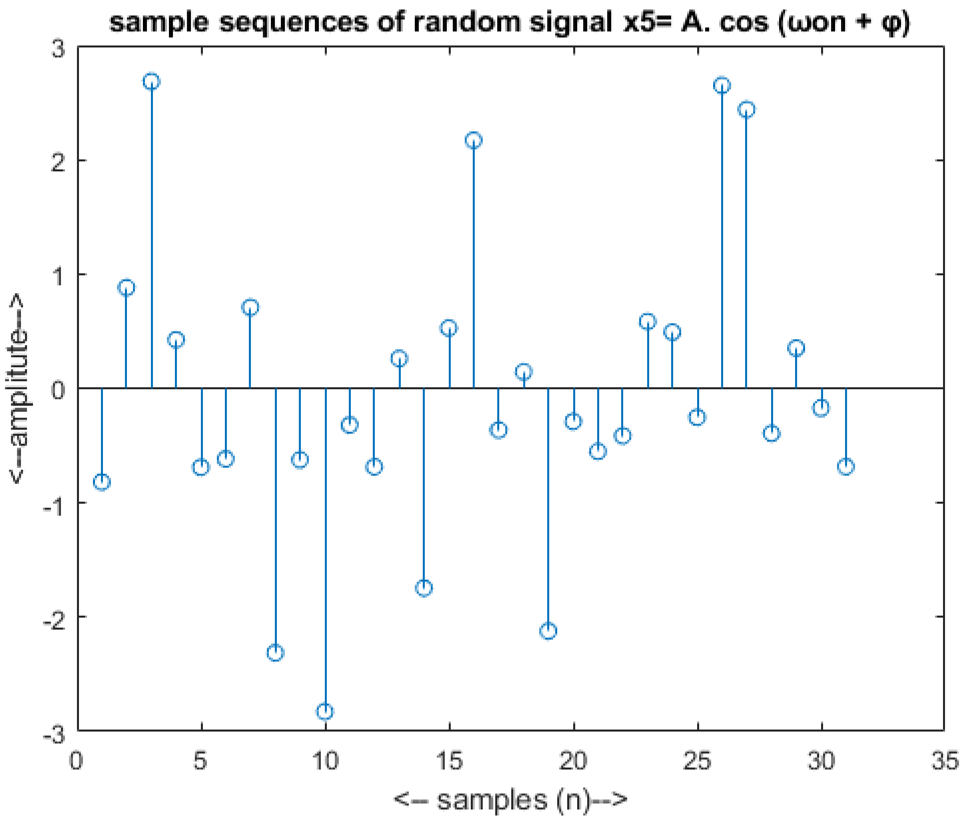

Gaussian random signal of length 75,σ2=3 μ=0
<--amplitute-->
<-- samples (n)-->


sample sequences of random signal x1= A. cos (ωon + φ)
<--amplitute-->
<-- samples (n)-->
3
2
1
0
-1
-2
-3
-4
0
5
10
15
20
25
30
35


sample sequences of random signal x2= A. cos (ωon + φ)
<--amplitute-->
<-- samples (n)-->
3
2
1
0
-1
-2
-3
-4
0
5
10
15
20
25
30
35


sample sequences of random signal x3= A. cos (ωon + φ)
<--amplitute-->
<-- samples (n)-->
4
3
2
1
0
-1
-2
-3
-4
0
5
10
15
20
25
30
35


sample sequences of random signal x4= A. cos (ωon + φ)
<--amplitute-->
<-- samples (n)-->
4
3
2
1
0
-1
-2
-3
-4
0
5
10
15
20
25
30
35



Inferences/comments:

We can generate the uniformly distributed random variables, random variables normally distributed with given mean and a variance for a given sequence length