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(結報) 實驗 5 Matlab 於基礎訊號運算之應用

DISCRETE-TIME SIGNALS: TIME-DOMAIN REPRESENTATION

1.1 GENERATION OF SEQUENCES

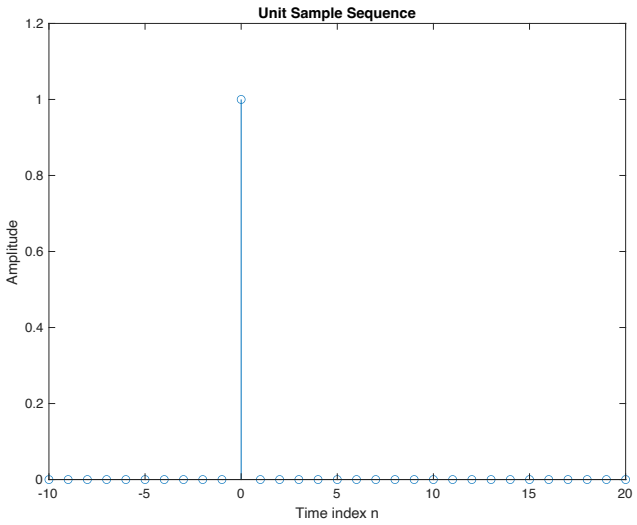
Project 1.1 Unit sample and unit step sequences

A copy of Program P1_1 is given below.

```
% Program P1_1
% Generation of a Unit Sample Sequence
clf;
% Generate a vector from -10 to 20
n = -10:20;
% Generate the unit sample sequence
u = [zeros(1,10) 1 zeros(1,20)];
% Plot the unit sample sequence
stem(n,u);
xlabel('Time index n');ylabel('Amplitude');
title('Unit Sample Sequence');
axis([-10 20 0 1.2]);
```

Answers:

Q1.1 The unit sample sequence `u[n]` generated by running Program P1_1 is shown below:



Q1.2 The purpose of `clf` command is – Clear current figure

The purpose of `axis` command is - Control axis scaling and appearance.

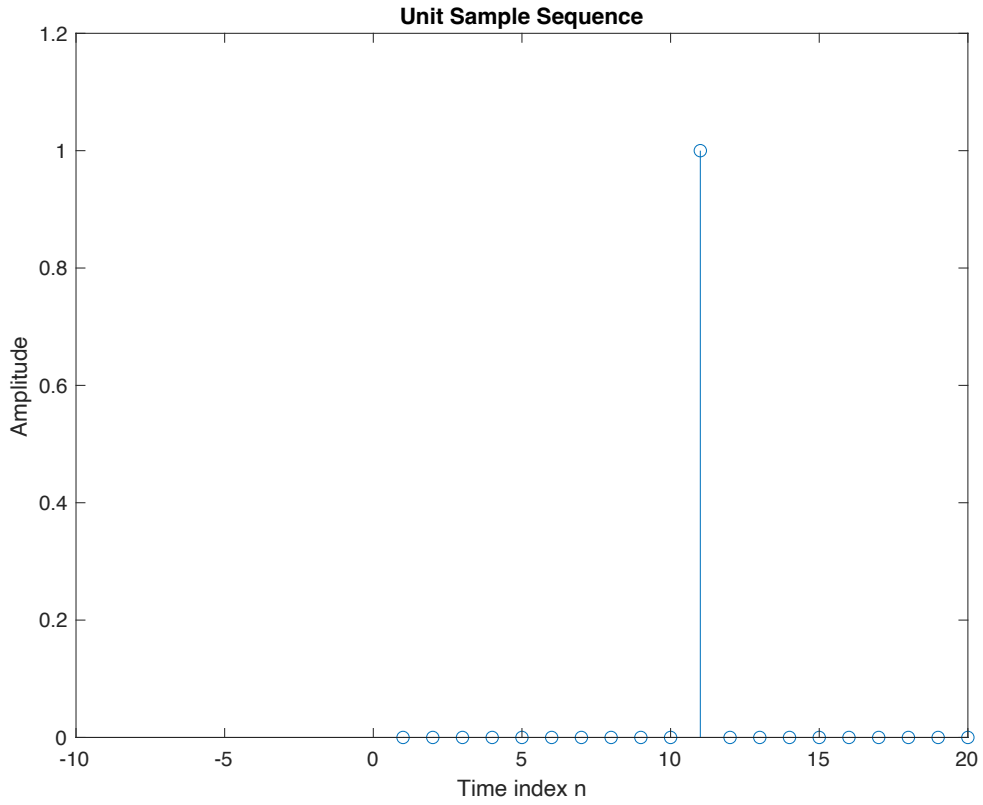
The purpose of `title` command is – input Graph title

The purpose of `xlabel` command is - X-axis label

The purpose of `ylabel` command is - Y-axis label

Q1.3 The modified Program P1_1 to generate a delayed unit sample sequence `ud[n]` with a delay of 11 samples is given below along with the sequence generated by running this program.

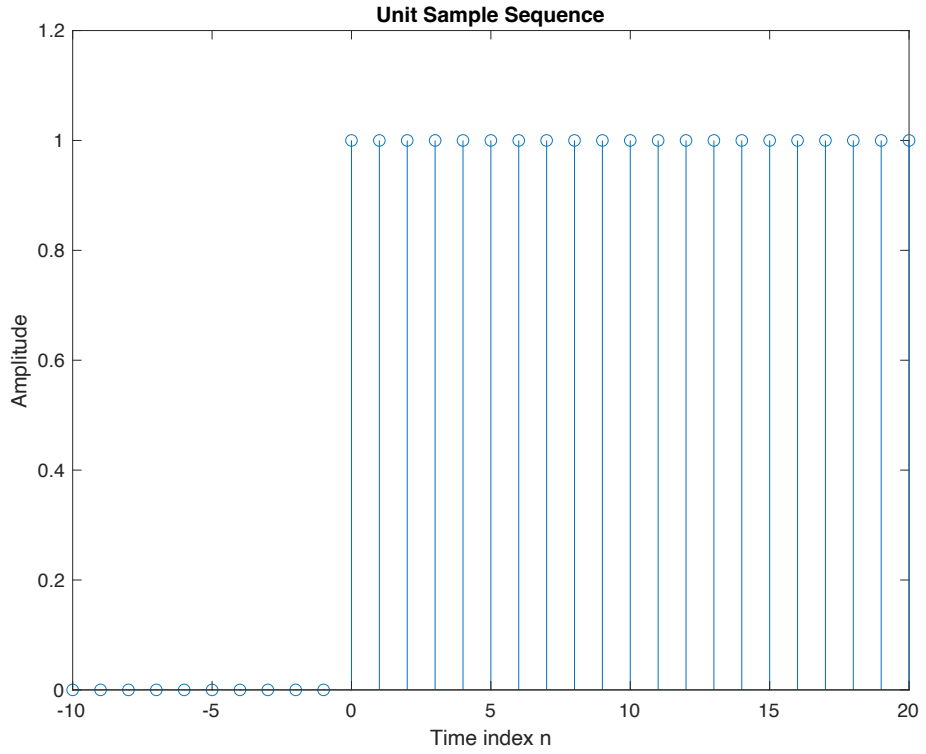
```
% Program P1_1
% Generation of a Unit Sample Sequence
clf;
% Generate a vector from -10 to 20
n = 1:31;
% Generate the unit sample sequence
u = [zeros(1,10) 1 zeros(1,20)];
% Plot the unit sample sequence
stem(n,u);
xlabel('Time index n');ylabel('Amplitude');
title('Unit Sample Sequence');
axis([-10 20 0 1.2]);
```



Q1.4 The modified Program P1_1 to generate a unit step sequence `s[n]` is given below along with the sequence generated by running this program.

```
% Program P1_1
% Generation of a Unit Sample Sequence
clf;
% Generate a vector from -10 to 20
n = -10:20;
% Generate the unit sample sequence
u = [zeros(1,10) 1 ones(1,20)];
% Plot the unit sample sequence
stem(n,u);
xlabel('Time index n');ylabel('Amplitude');
title('Unit Sample Sequence');
axis([-10 20 0 1.2]);
```

< Insert program code here. Copy from m-file(s) and paste. >

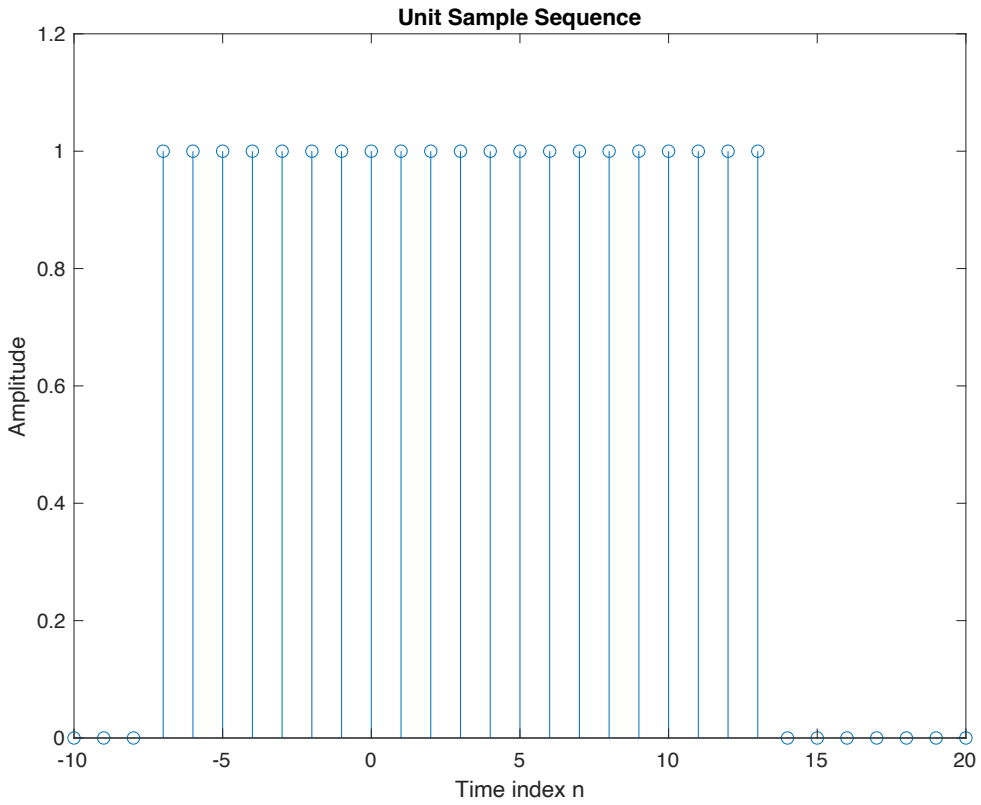


< Insert program code here. Copy from m-file(s) and paste. >

< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

Q1.5 The modified Program P1_1 to generate a unit step sequence `sd[n]` with an advance of 7 samples is given below along with the sequence generated by running this program.

```
% Program P1_1
% Generation of a Unit Sample Sequence
clf;
% Generate a vector from -10 to 20
n = -10:20;
% Generate the unit sample sequence
u = [zeros(1,3) 1 ones(1,20) zeros(1,7)];
% Plot the unit sample sequence
stem(n,u);
xlabel('Time index n');ylabel('Amplitude');
title('Unit Sample Sequence');
axis([-10 20 0 1.2]);
```



< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

Project 1.2 Exponential signals

A copy of Programs P1_2 and P1_3 are given below.

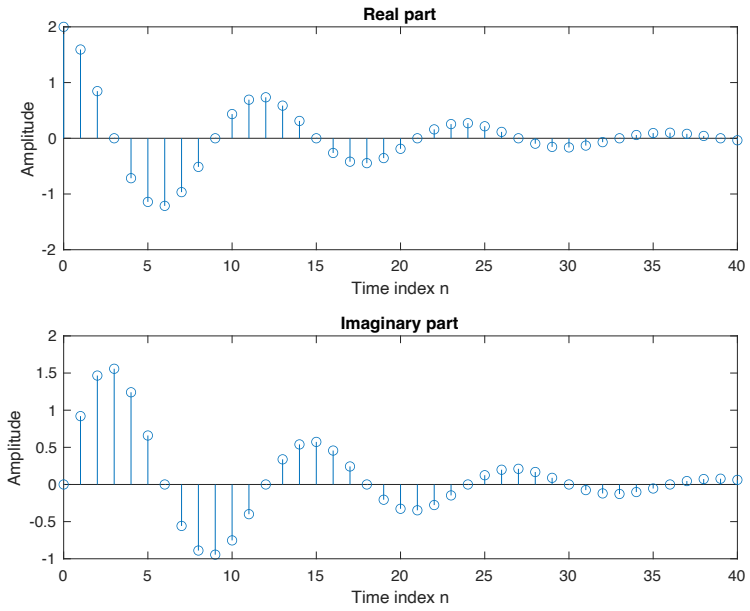
```
% Program P1_2
% Generation of a complex exponential sequence
clf;
c = -(1/12)+(pi/6)*i;
```

```
K = 2;
n = 0:40;
x = K*exp(c*n);
subplot(2,1,1);
stem(n,real(x));
xlabel('Time index n');ylabel('Amplitude');
title('Real part');
subplot(2,1,2);
stem(n,imag(x));
xlabel('Time index n');ylabel('Amplitude');
title('Imaginary part');

% Program P1_3
% Generation of a real exponential sequence
clf;
n = 0:35; a = 1.2; K = 0.2;
x = K*a.^n;
stem(n,x);
xlabel('Time index n');ylabel('Amplitude');
```

< Insert program code here. Copy from m-file(s) and paste. >

Answers:

Q1.6 The complex-valued exponential sequence generated by running Program P1_2 is shown below:

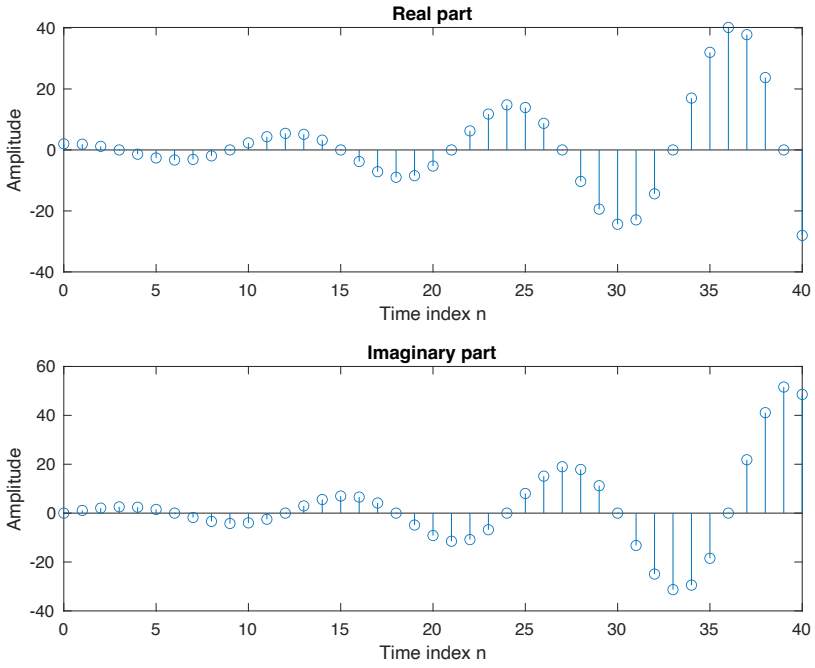


< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

Q1.7 The parameter controlling the rate of growth or decay of this sequence is - c

The parameter controlling the amplitude of this sequence is – K

Q1.8 The result of changing the parameter `c` to `(1/12)+(pi/6)*i` is – disperse

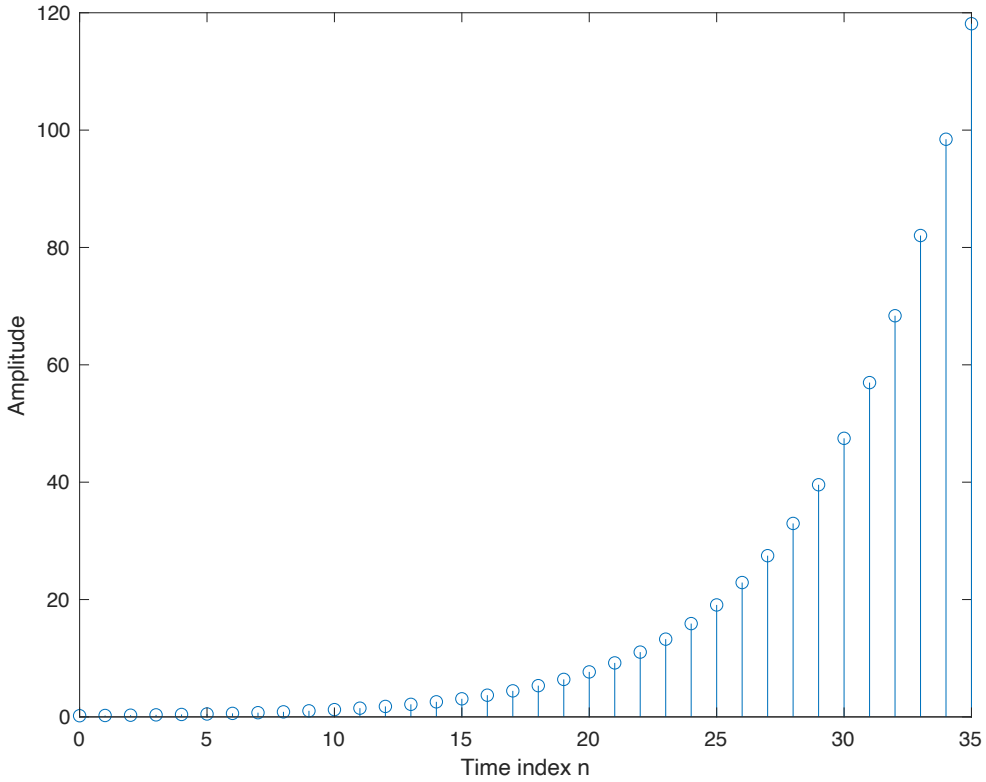


Q1.9 The purpose of the operator `real` is – get real part of complex

The purpose of the operator `imag` is – get imaginary part of complex

Q1.10 The purpose of the command `subplot` is – Create axes in tiled positions

Q1.11 The real-valued exponential sequence generated by running Program P1_3 is shown below:



< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

Q1.12 The parameter controlling the rate of growth or decay of this sequence is -a

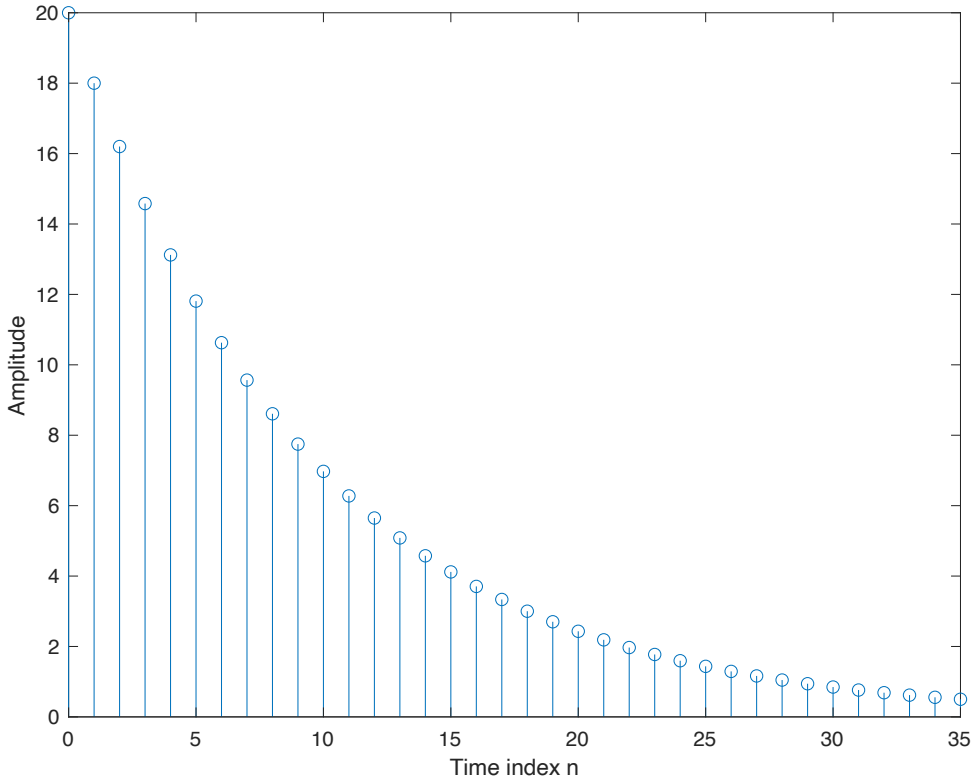
The parameter controlling the amplitude of this sequence is - k

Q1.13 The difference between the arithmetic operators ^ and .^ is –

^ : X^y is X to the y power if y is a scalar and X is square

.^ denotes element-by-element powers

Q1.14 The sequence generated by running Program P1_3 with the parameter a changed to 0.9 and the parameter K changed to 20 is shown below:



< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

Q1.15 The length of this sequence is - 36

It is controlled by the following MATLAB command line: n = 0:35;

It can be changed to generate sequences with different lengths as follows (give an example command line and the corresponding length):

n = input("input sequence length");

m = 0:n-1;

length of m = n.

Q1.16 The energies of the real-valued exponential sequences x[n]generated in Q1.11 and Q1.14 and computed using the command sum are –

Q1.11 energy =sum(real(x).*real(x)) =14.3373

Q1.14 energy =sum(real(x).*real(x)) = 2.1042e+03

Project 1.3 Sinusoidal sequences

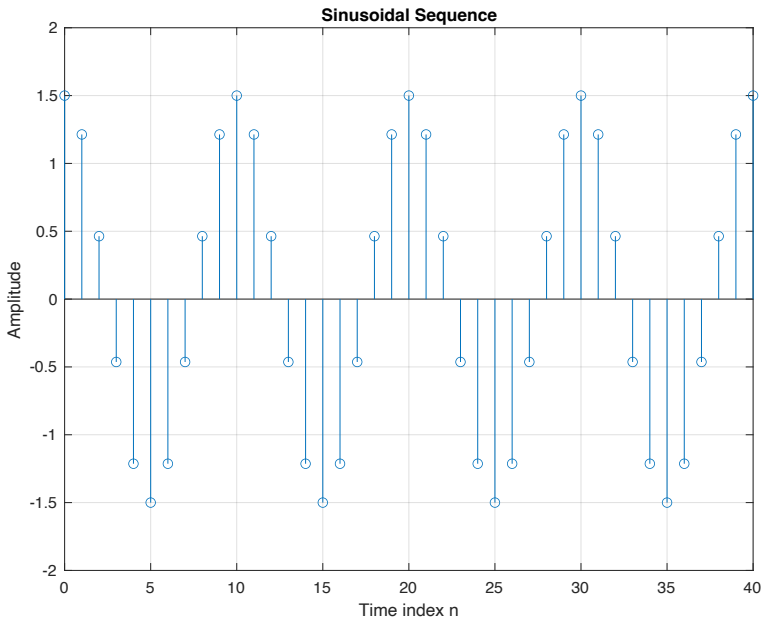
A copy of Program P1_4 is given below.

```
% Program P1_4
% Generation of a sinusoidal sequence
n = 0:40;
f = 0.1;
phase = 0;
A = 1.5;
arg = 2*pi*f*n - phase;
x = A*cos(arg);
clf;                % Clear old graph
stem(n,x);          % Plot the generated sequence
axis([0 40 -2 2]);
grid;
title('Sinusoidal Sequence');
xlabel('Time index n');
ylabel('Amplitude');
axis;
```

< Insert program code here. Copy from m-file(s) and paste. >

Answers:

Q1.17 The sinusoidal sequence generated by running Program P1_4 is displayed below.



< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

Q1.18 The frequency of this sequence is – 0.1

It is controlled by the following MATLAB command line: f = 0.1;

A sequence with new frequency _____ can be generated by the following command line: f = input("input frequency")

The parameter controlling the phase of this sequence is -phase

The parameter controlling the amplitude of this sequence is -A

The period of this sequence is - 10

Q1.19 The length of this sequence is - 41

It is controlled by the following MATLAB command line: n = 0:40

A sequence with new length _____ can be generated by the following command line:

```
length = input("input array length");
n = 0:length-1;
```

Q1.20 The average power of the generated sinusoidal sequence is – 47.25

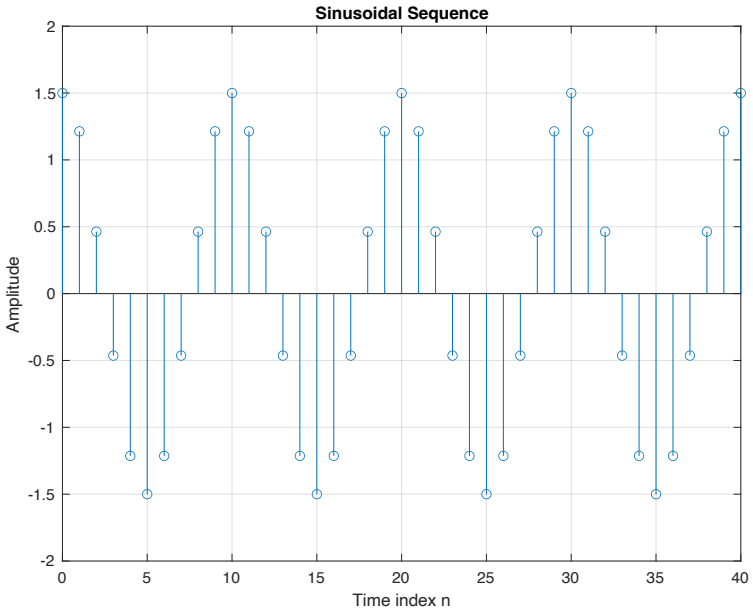
Q1.21 The purpose of `axis` command is - Control axis scaling and appearance.

The purpose of `grid` command is – Grid lines.

Q1.22 The modified Program P1_4 to generate a sinusoidal sequence of frequency 0.9 is given below along with the sequence generated by running it.

```
% Program P1_4
% Generation of a sinusoidal sequence
n = 0:40;
%f = 0.1;
f = input("input frequency")
phase = 0;
A = 1.5;
arg = 2*pi*f*n - phase;
x = A*cos(arg);
clf;                % Clear old graph
stem(n,x);          % Plot the generated sequence
axis([0 40 -2 2]);
grid;
title('Sinusoidal Sequence');
xlabel('Time index n');
ylabel('Amplitude');
axis;
```

< Insert program code here. Copy from m-file(s) and paste. >

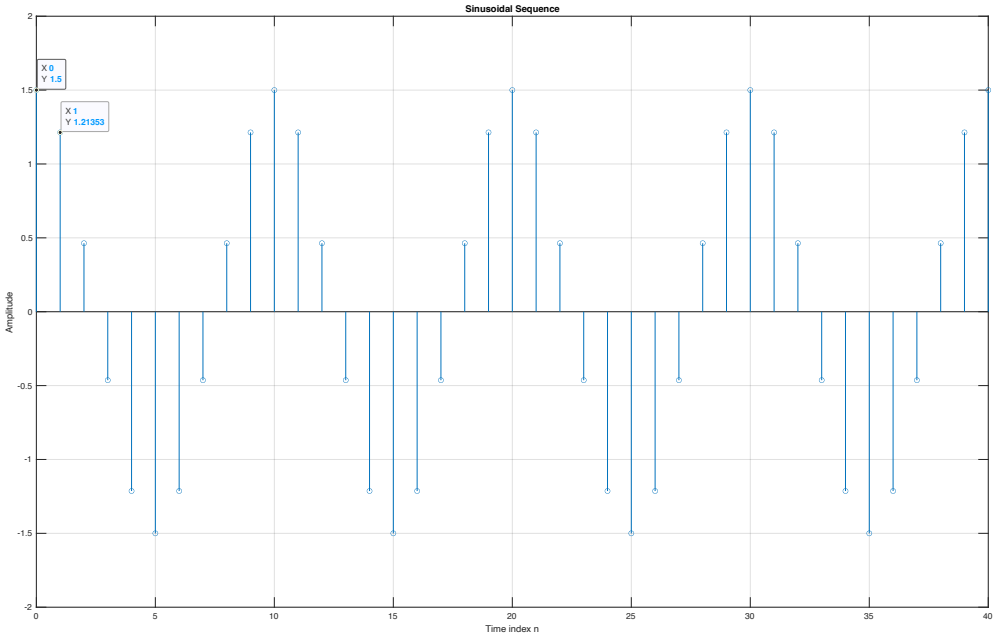


< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

A comparison of this new sequence with the one generated in Question Q1.17 shows -

頻率不同，週期相同，x 值不同。

A sinusoidal sequence of frequency 1.1 generated by modifying Program P1_4 is shown below.

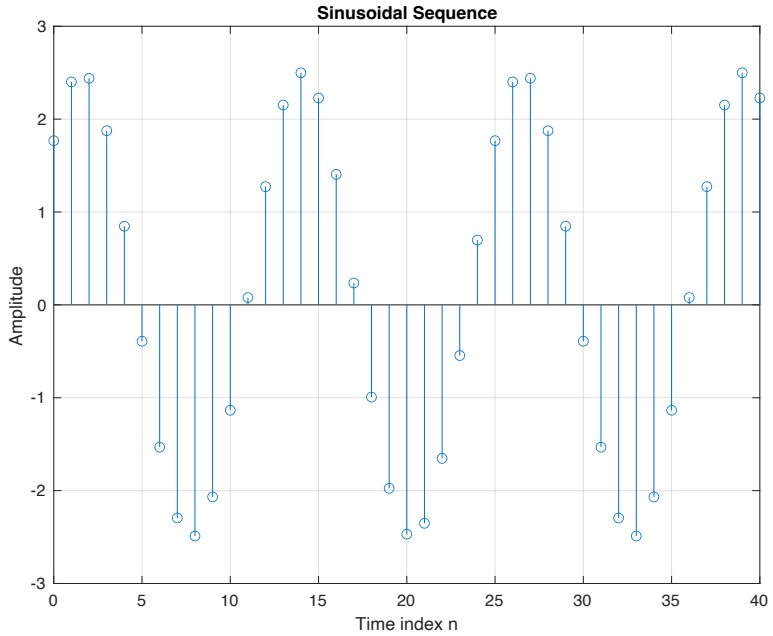


< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

A comparison of this new sequence with the one generated in Question Q1.17 shows -

頻率不同，週期相同，x 值不同

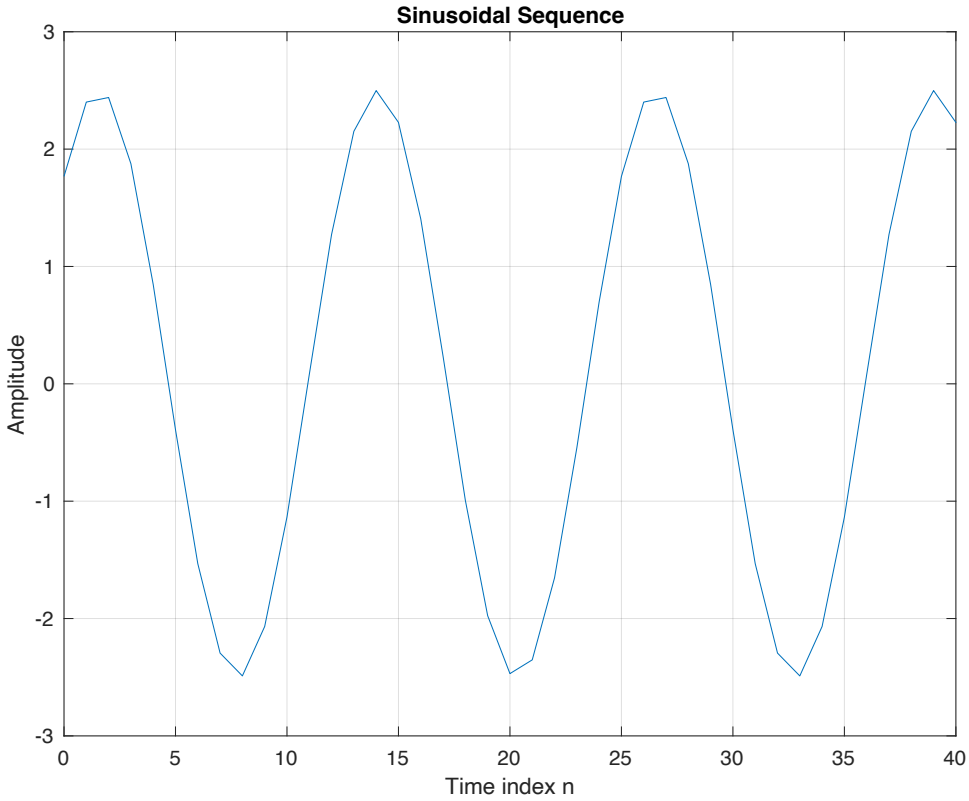
Q1.23 The sinusoidal sequence of length 50, frequency 0.08, amplitude 2.5, and phase shift of 90 degrees generated by modifying Program P1_4 is displayed below.



< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

The period of this sequence is - 25

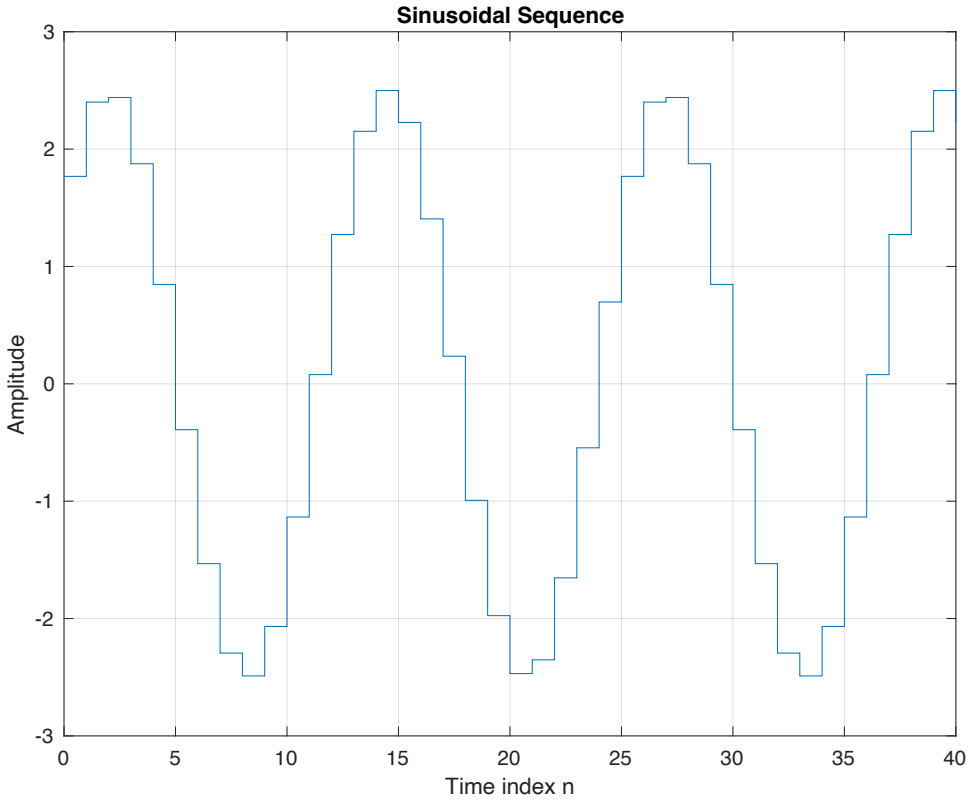
Q1.24 By replacing the `stem` command in Program P1_4 with the `plot` command, the plot obtained is as shown below:



< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

The difference between the new plot and the one generated in Question Q1.17 is -

Q1.25 By replacing the `stem` command in Program P1_4 with the `stairs` command the plot obtained is as shown below:



< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

The difference between the new plot and those generated in Questions Q1.17 and Q1.24 is – Plot displays figure by continuous line. Stem display figure by discrete impulse.

Project 1.4 Random signal

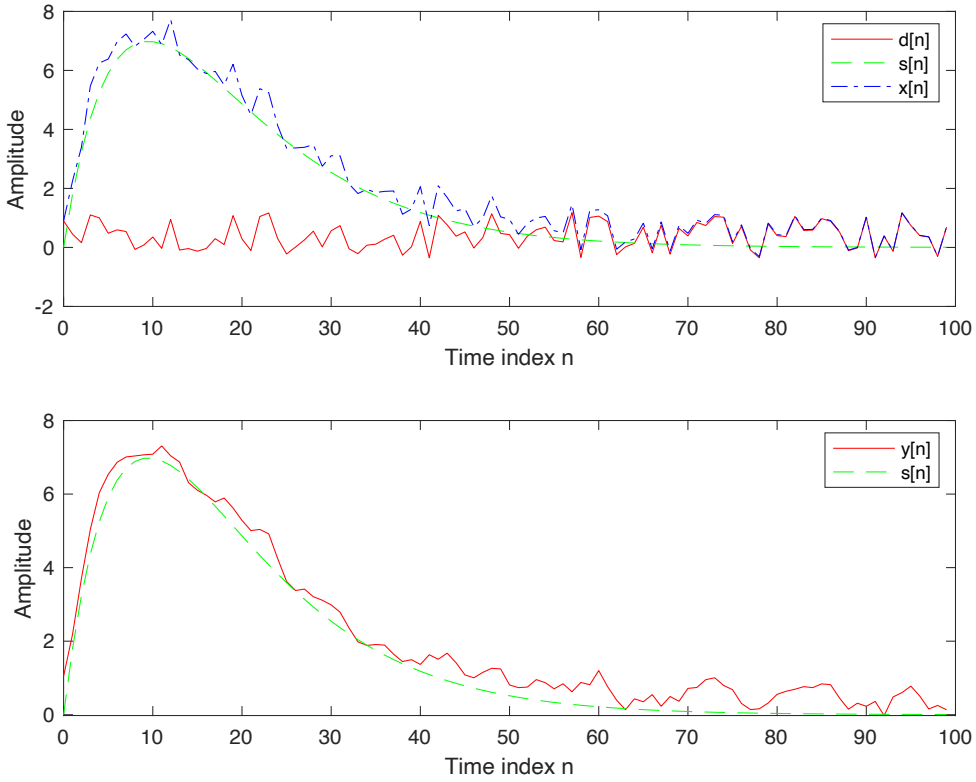
Answers:

Q1.26 The MATLAB program to generate and display a random signal of length 100 with elements uniformly distributed in the interval [–2, 2] is given below along with the plot of the random sequence generated by running the program:

```
% Program P1_5
% Signal Smoothing by Averaging
clear;
clf;
R = 100;
r = 2*rand(R,1);
d = 0.8*(r - 0.5); % Generate random noise
m = 0:R-1;
s = 2*m.*(0.9.^m); % Generate uncorrupted signal
x = s + d'; % Generate noise corrupted signal
subplot(2,1,1);
plot(m,d','r-',m,s,'g--',m,x,'b-.');
```

```
xlabel('Time index n');ylabel('Amplitude');
legend('d[n] ','s[n] ','x[n] ');
x1 = [0 0 x];x2 = [0 x 0];x3 = [x 0 0];
y = (x1 + x2 + x3)/3;
subplot(2,1,2);
plot(m,y(2:R+1),'r-',m,s,'g--');
legend( 'y[n] ','s[n] ');
xlabel('Time index n');ylabel('Amplitude');
```

< Insert program code here. Copy from m-file(s) and paste. >



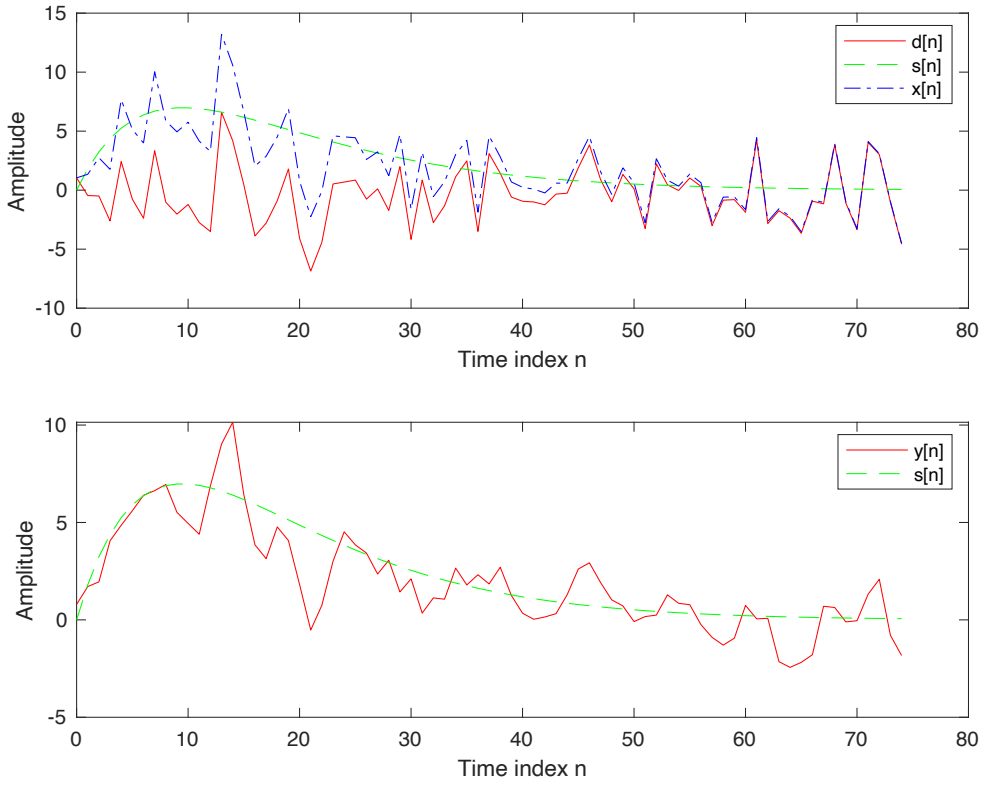
< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

Q1.27 The MATLAB program to generate and display a Gaussian random signal of length 75 with elements normally distributed with zero mean and a variance of 3 is given below along with the plot of the random sequence generated by running the program:

```
% Program P1_5
% Signal Smoothing by Averaging
clear;
clf;
R = 75;
r = 2*normrnd(0,sqrt(3),[R,1]);
d = 0.8*(r - 0.5); % Generate random noise
m = 0:R-1;
s = 2*m.*(0.9.^m); % Generate uncorrupted signal
x = s + d'; % Generate noise corrupted signal
```

```
subplot(2,1,1);
plot(m,d','r-',m,s,'g--',m,x,'b-.');
xlabel('Time index n');ylabel('Amplitude');
legend('d[n] ','s[n] ','x[n] ');
x1 = [0 0 x];x2 = [0 x 0];x3 = [x 0 0];
y = (x1 + x2 + x3)/3;
subplot(2,1,2);
plot(m,y(2:R+1),'r-',m,s,'g--');
legend( 'y[n] ','s[n] ');
xlabel('Time index n');ylabel('Amplitude');
```

< Insert program code here. Copy from m-file(s) and paste. >



< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

Q1.28 The MATLAB program to generate and display five sample sequences of a random sinusoidal signal of length 31

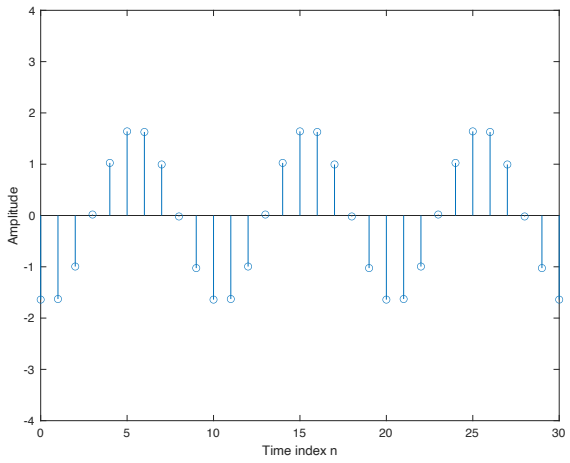
$$\{X[n]\} = \{A\cos(\omega_0 n + \phi)\}$$

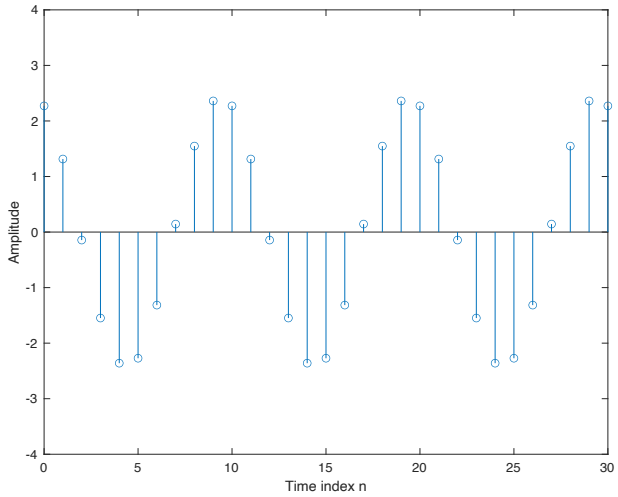
where the amplitude A and the phase ϕ are statistically independent random variables with uniform probability distribution in the range $0 \bullet A \bullet 4$ for the amplitude and in

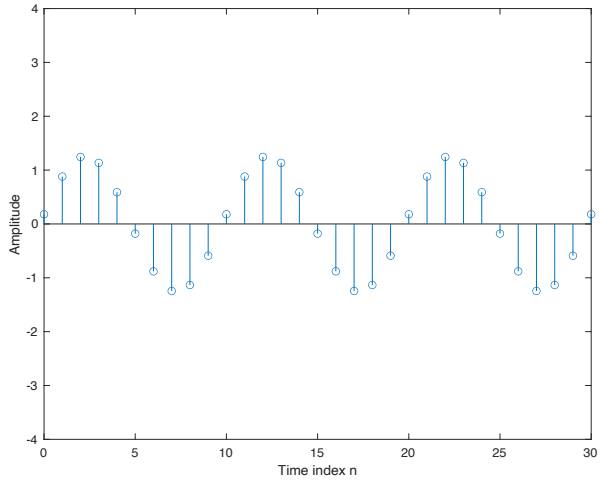
the range $0 \le \phi \le 2\pi$ for the phase is given below. Also shown are five sample sequences generated by running this program five different times.

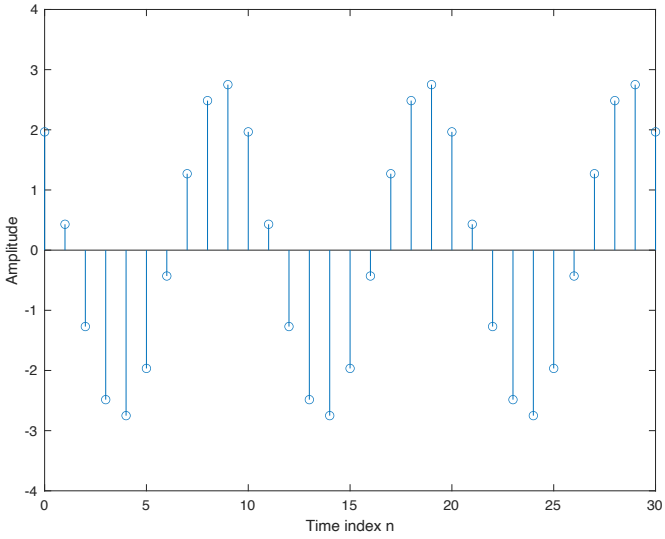
```
clear;clc;
n = 0:30;
%Amplitude
a = 0;
b = 4;
A = a + (b-a).*rand(1);
%phase
a = 0;
b = 2*pi;
fi = a + (b-a).*rand(1);
%frequeny
f = 0.1;

X = A*(cos(2*pi*f*n+fi));
%plot
stem(n,X);
axis([0,30,-4,4]);
xlabel('Time index n');ylabel('Amplitude');
```

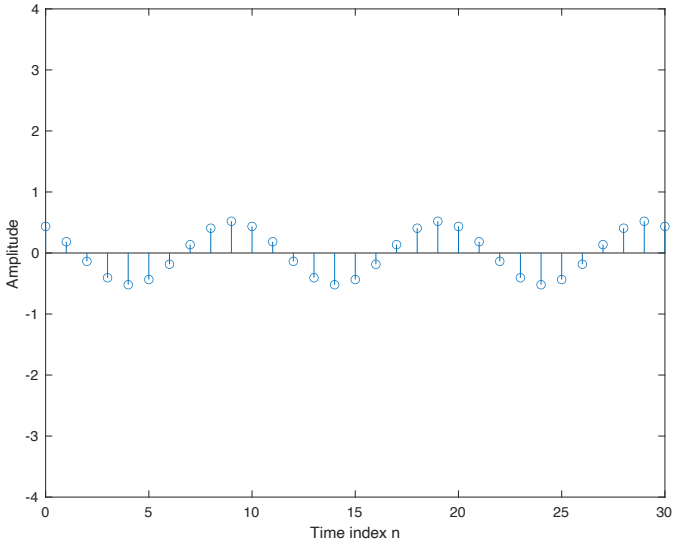
< Insert program code here. Copy from m-file(s) and paste. >




Amplitude
Time index n


Amplitude
Time index n


Amplitude
Time index n



< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

1.2 SIMPLE OPERATIONS ON SEQUENCES

Project 1.5 Signal Smoothing

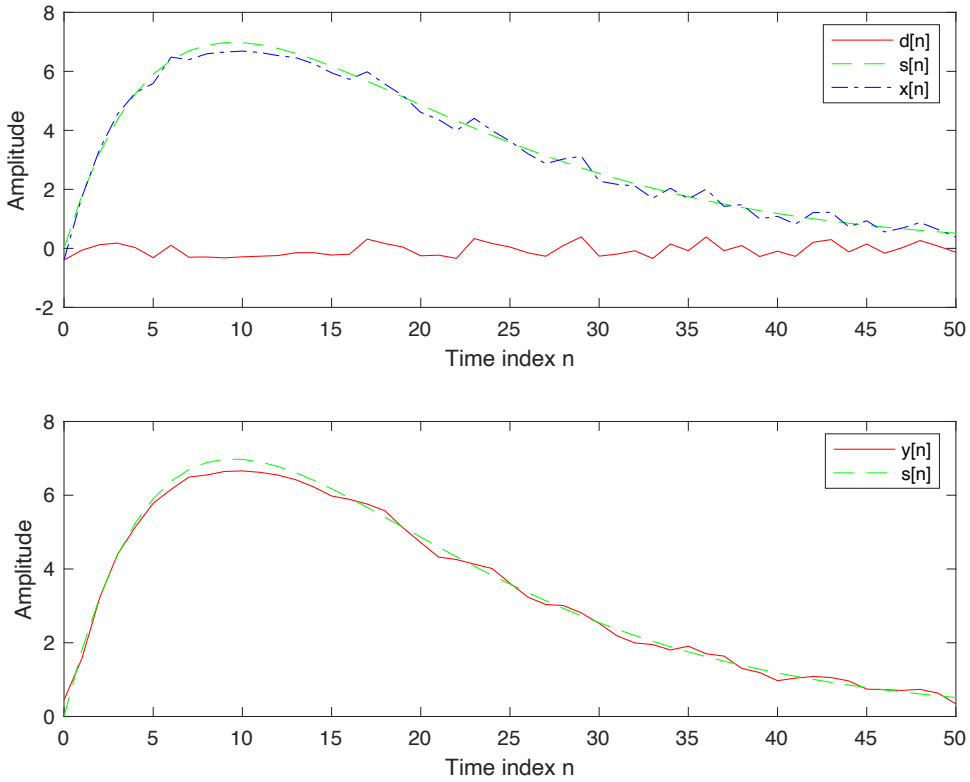
A copy of Program P1_5 is given below.

```
% Program P1_5
% Signal Smoothing by Averaging
clear;
clf;
R = 51;
d = 0.8*(rand(R,1) - 0.5); % Generate random noise
m = 0:R-1;
s = 2*m.*(0.9.^m); % Generate uncorrupted signal
x = s + d'; % Generate noise corrupted signal
subplot(2,1,1);
plot(m,d','r-',m,s,'g--',m,x,'b-.');
xlabel('Time index n');ylabel('Amplitude');
legend('d[n] ','s[n] ','x[n] ');
x1 = [0 0 x];x2 = [0 x 0];x3 = [x 0 0];
y = (x1 + x2 + x3)/3;
subplot(2,1,2);
plot(m,y(2:R+1),'r-',m,s,'g--');
legend( 'y[n] ','s[n] ');
xlabel('Time index n');ylabel('Amplitude');
```

< Insert program code here. Copy from m-file(s) and paste. >

Answers:

Q1.29 The signals generated by running Program P1_5 are displayed below:



< Insert MATLAB figure(s) here. Copy from figure window(s) and paste. >

Q1.30 The uncorrupted signal `s[n]` is - `2*m.*(0.9.^m)` which is green line
The additive noise `d[n]` is - `0.8*(rand(R,1) - 0.5)` `which is` red line

Q1.31 The statement `x = s + d` CAN / CANNOT be used to generate the noise corrupted signal because - It can be used to generate the noise corrupted signal by additive noise.

Q1.32 The relations between the signals `x1`, `x2`, and `x3`, and the signal `x` are -

X adds two zero-sample to be x1、x2、x3, if x2 is current signal, x1 would be delay 1 sample, and x3 would be advance 1 sample.

Q1.33 The purpose of the `legend` command is - 在座標上添加圖例。