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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

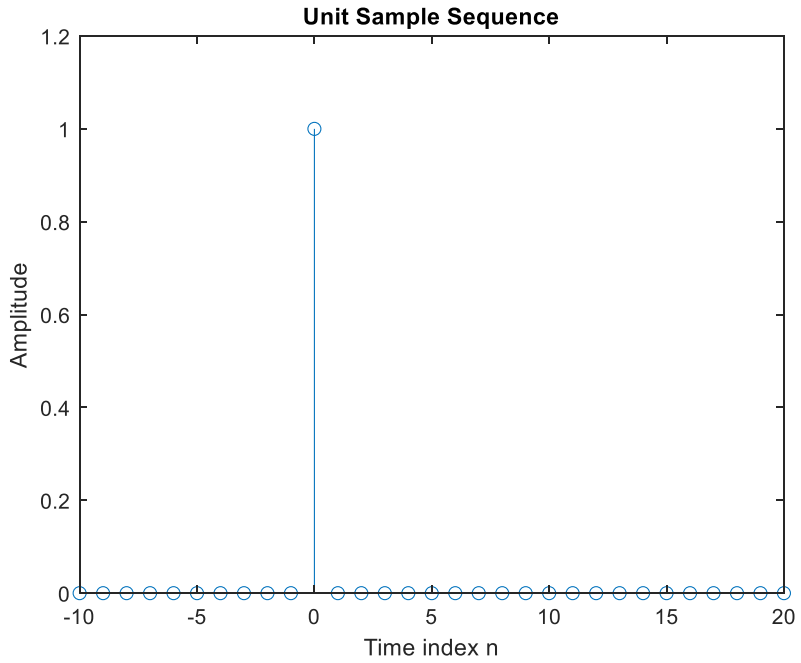
Project 1.1 Unit sample and unit step sequences

A copy of Program P1_1 is given below.

Answers:

```
% 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]);
```

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 –

清除圖形視窗中舊有的資料(避免疊圖)

The purpose of `axis` command is –

規範 x 軸、y 軸的起始範圍[a b c d]到圖形上，a、b 分別為 x 軸的起、始，c、d 分別為 y 軸的起、始。

The purpose of `title` command is –

命名圖表名稱並顯示在圖窗上。

The purpose of `xlabel` command is –

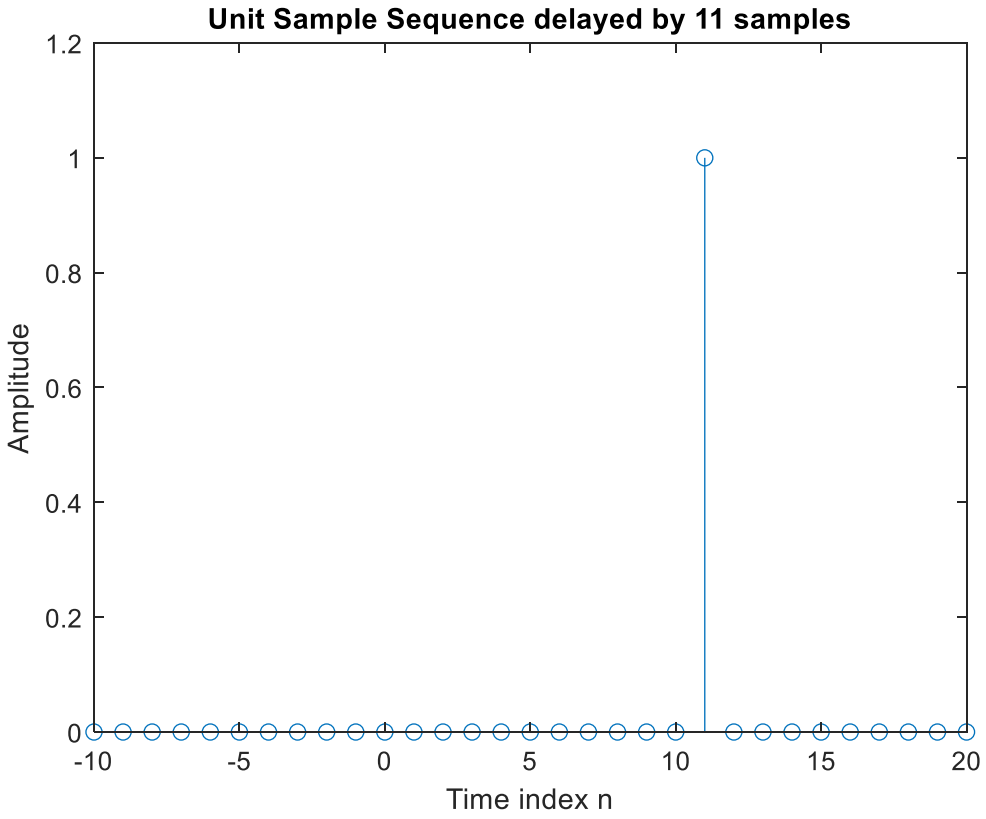
命名 x 座標軸並顯示在圖窗上。

The purpose of `ylabel` command is –

命名 y 座標軸並顯示在圖窗上。

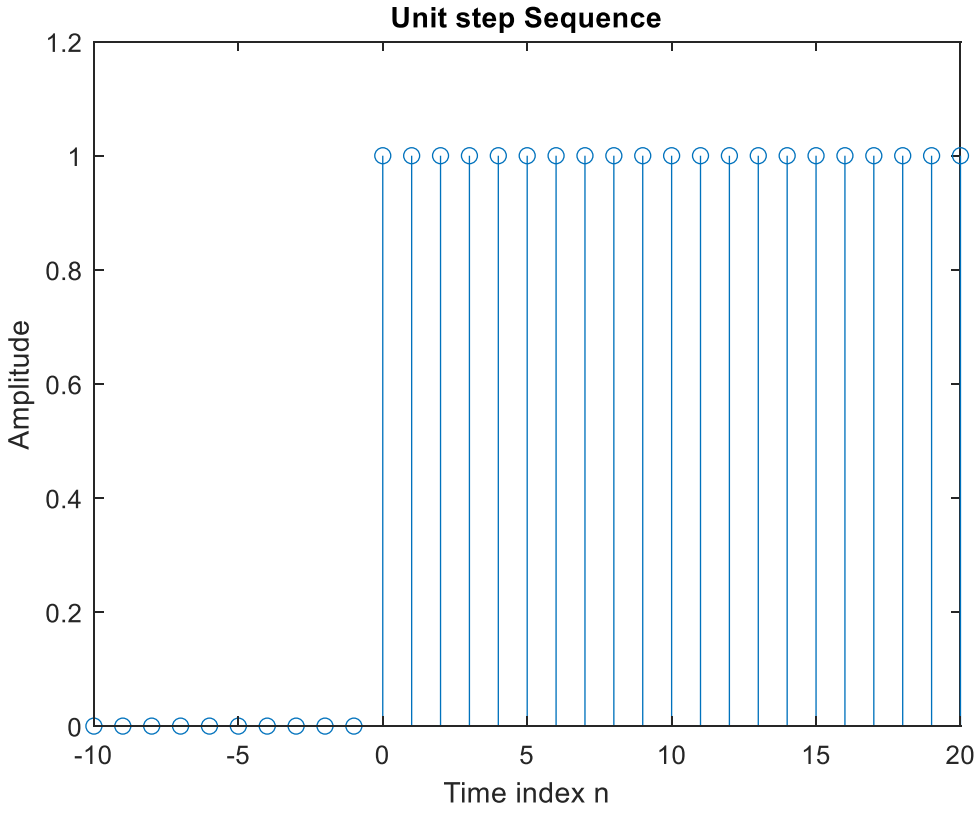
Q1.3 The modified Program P1_1 to generate a delayed unit sample sequence `ud[n]` with a delay of 11 samples is given below along with the sequence generated by running this program.

```
% Program P1_1
% Generation of a Unit Sample Sequence
clf;
% Generate a vector from -10 to 20
n = -10:20;
% Generate the unit sample sequence
ud = [zeros(1,10+11) 1 zeros(1,20-11)]; % 1 右邊訊號減少，1 左邊訊號增加
% Plot the unit sample sequence
stem(n,ud);
xlabel('Time index n');ylabel('Amplitude');
title('Unit Sample Sequence delayed by 11 samples'); %change the title
axis([-10 20 0 1.2]);
```



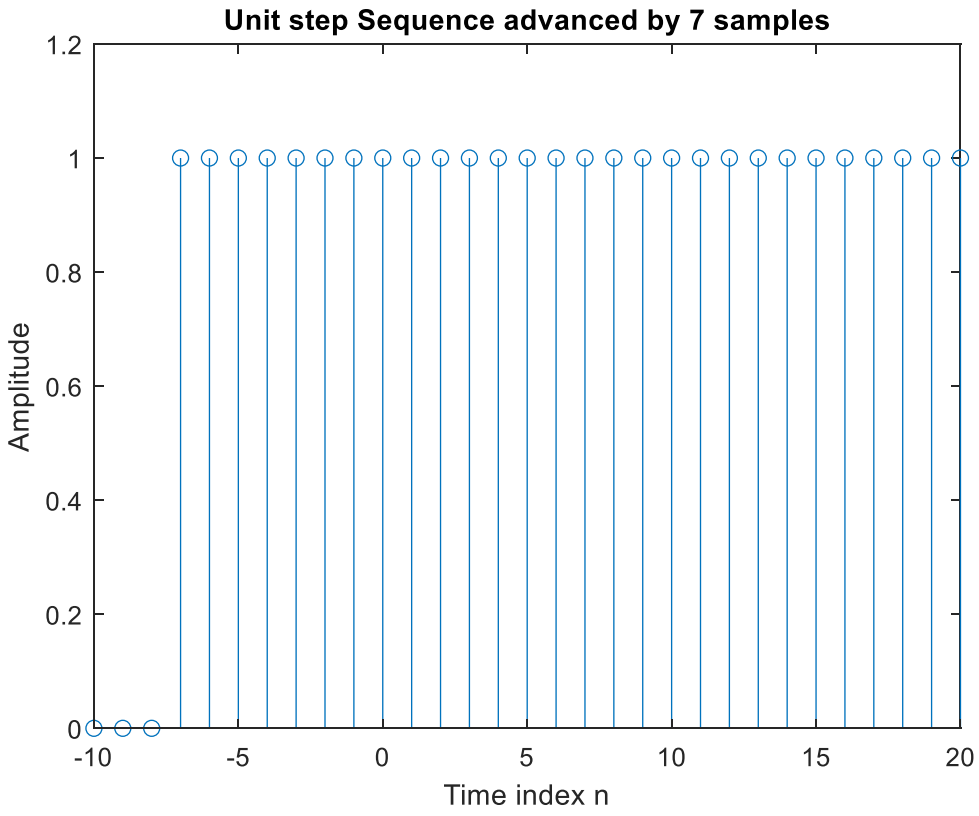
Q1.4 The modified Program P1_1 to generate a unit step sequence `s[n]` is given below along with the sequence generated by running this program.

```
% 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
s = [zeros(1,10) 1 ones(1,20)]; % zeros(1,20) changes to ones(1,20)
% Plot the unit sample sequence
stem(n,s);
xlabel('Time index n');ylabel('Amplitude');
title('Unit step Sequence'); %change the title
axis([-10 20 0 1.2]);
```



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
s = [zeros(1,10-7) 1 ones(1,20+7)]; % 圖形左移 7 單位
% Plot the unit sample sequence
stem(n,s);
xlabel('Time index n');ylabel('Amplitude');
title('Unit step Sequence advanced by 7 samples'); %change the title
axis([-10 20 0 1.2]);
```



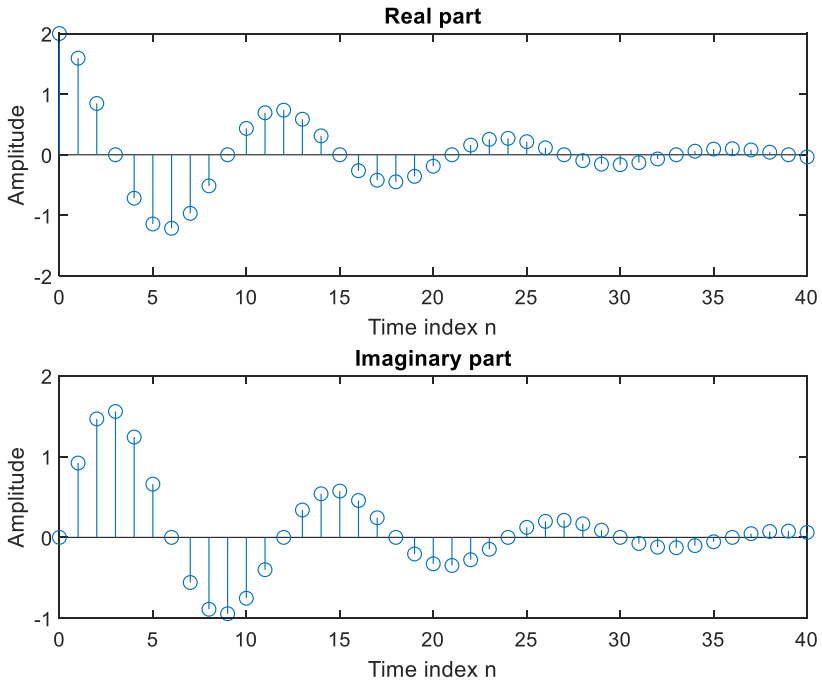
Project 1.2 Exponential signals

A copy of Programs P1_2 and P1_3 are 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
s = [zeros(1,10-7) 1 ones(1,20+7)]; % 圖形左移 7 單位
% Plot the unit sample sequence
stem(n,s);
xlabel('Time index n');ylabel('Amplitude');
title('Unit step Sequence advanced by 7 samples'); %change the title
axis([-10 20 0 1.2]);

% 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');
```

Answers:

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



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

c 當中的 -1/12

The parameter controlling the amplitude of this sequence is –

K (值為 2)

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

圖形從 decay 變為 decline (e^(n/12) 隨 n 值增加而增加)。

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

取出函數的實部

The purpose of the operator `imag` is –

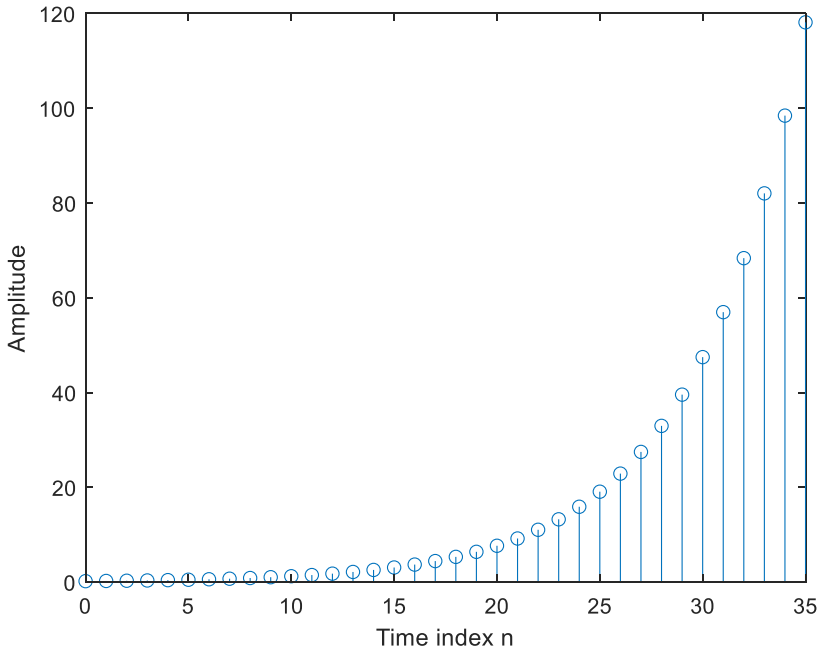
取出函數的虛部

Q1.10 The purpose of the command `subplot` is –

在圖窗中顯示多個子圖並排版，

subplot(m,n,p)，m 表示列數，n 表示行數，p 為在特定位置新增子圖。

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



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

a(值為 1.2)

The parameter controlling the amplitude of this sequence is -

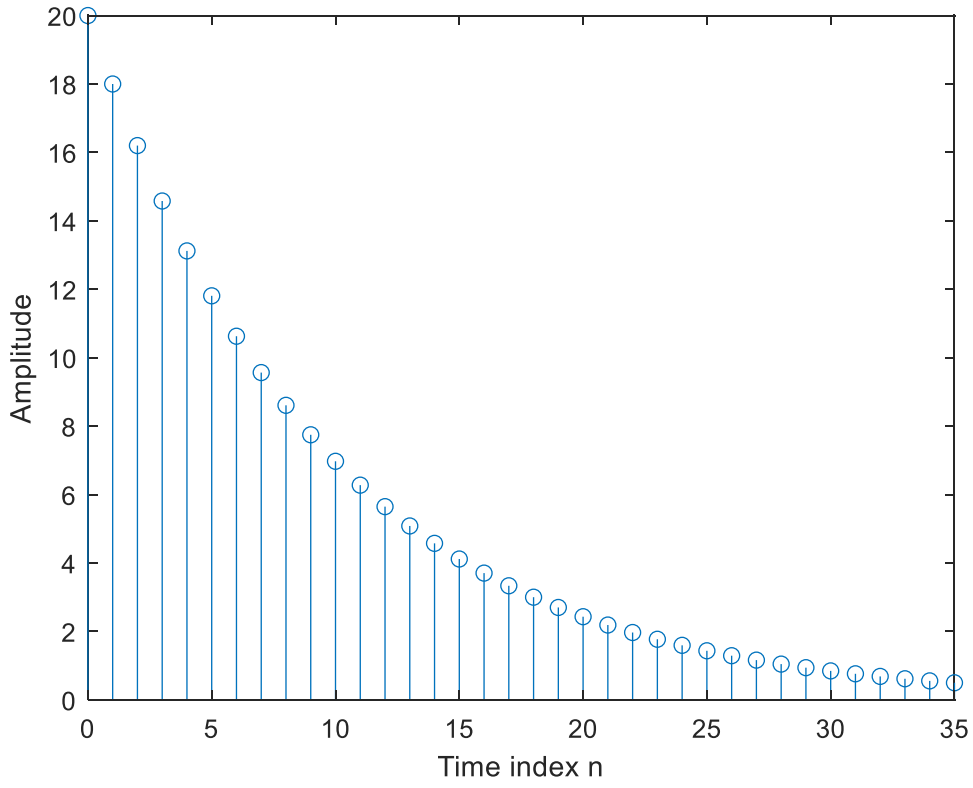
K(值為 0.2)

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

a ^ x : x 為方陣，對 方陣做次冪

a .^ x: x 為向量，此結果為按元素逐一列出其 次冪 的結果。

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:



Q1.15 The length of this sequence is –

長度為 36

It is controlled by the following MATLAB command line:

n = 0 : 35 ，numbers of samples = 35+1 = 36

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

n = 1 : 100 ，lengths = 100

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 –

For Q1.11 ，sum = 4.5673e+04

For Q1.14，sum = 2.1042e+03

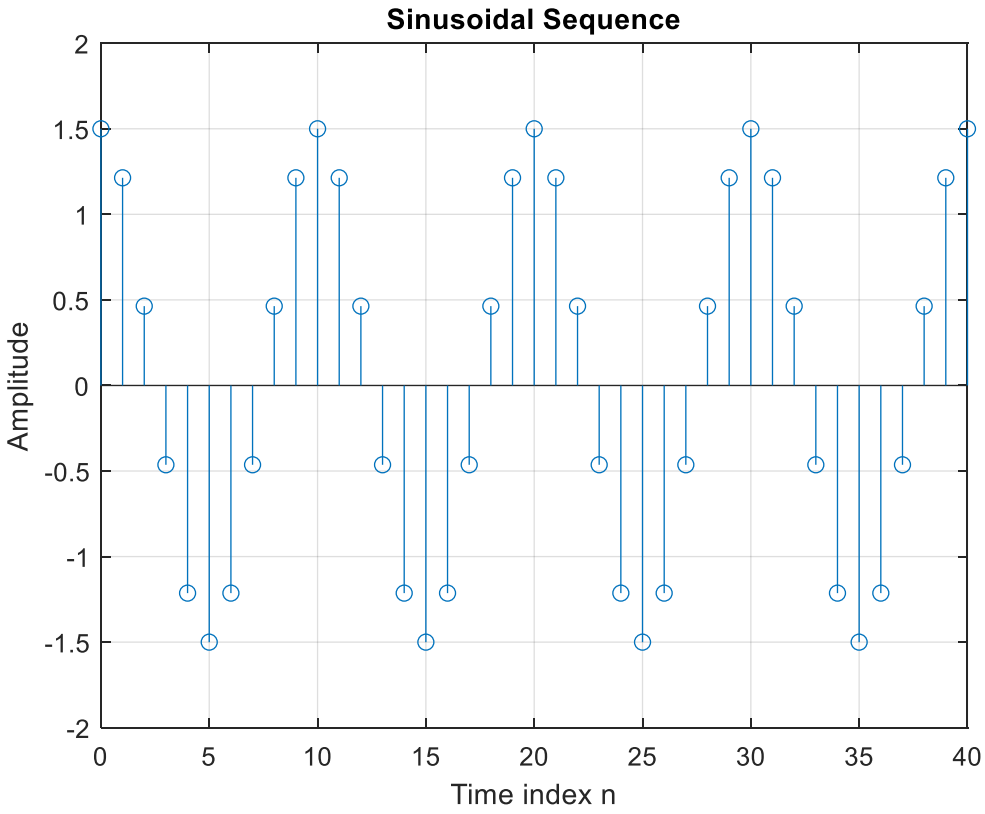
Project 1.3 Sinusoidal sequences

A copy of Program P1_4 is given below.

Answers:

```
% 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;
```

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



Q1.18 The frequency of this sequence is –

f (值為 0.1)

It is controlled by the following MATLAB command line:

f = 0.1;

A sequence with new frequency __5___ can be generated by the following command line:

f = 5;

The parameter controlling the phase of this sequence is –

phase(其值為 0)

The parameter controlling the amplitude of this sequence is –

A(其值為 1.5)

The period of this sequence is -

Period is 10

Q1.19 The length of this sequence is –

Length is 41

It is controlled by the following MATLAB command line:

n = 0:40;

A sequence with new length ___50__ can be generated by the following command line:

n = 1 : 51;

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

```
Av_power = x(11:20)*x(11:20)'/10
```

Average power = 1.250

Q1.21 The purpose of `axis` command is –

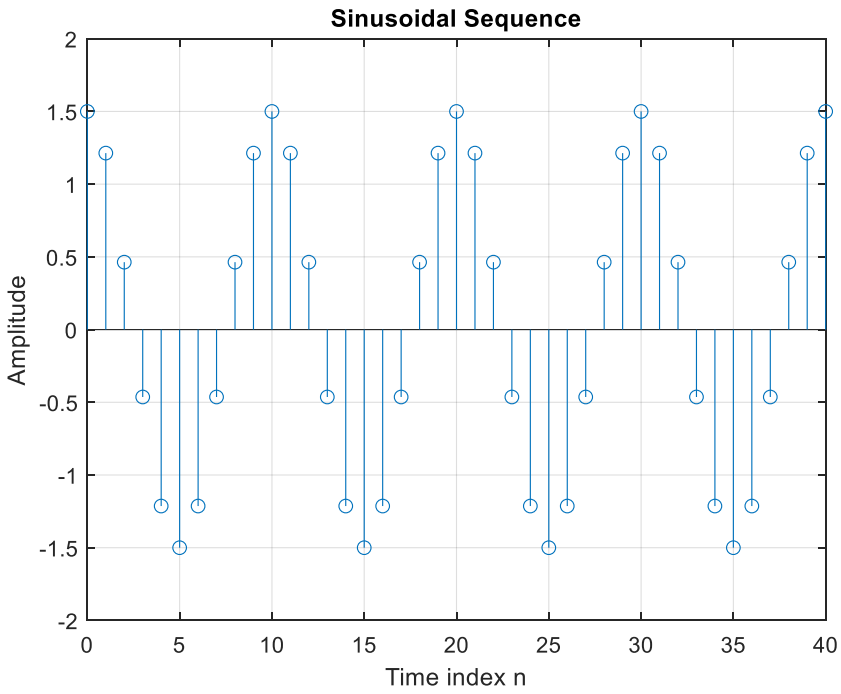
自動設置座標軸範圍(在 P1_4 中 有無 axis 圖表並無差異)

The purpose of `grid` command is –

在圖表上顯示網格

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.

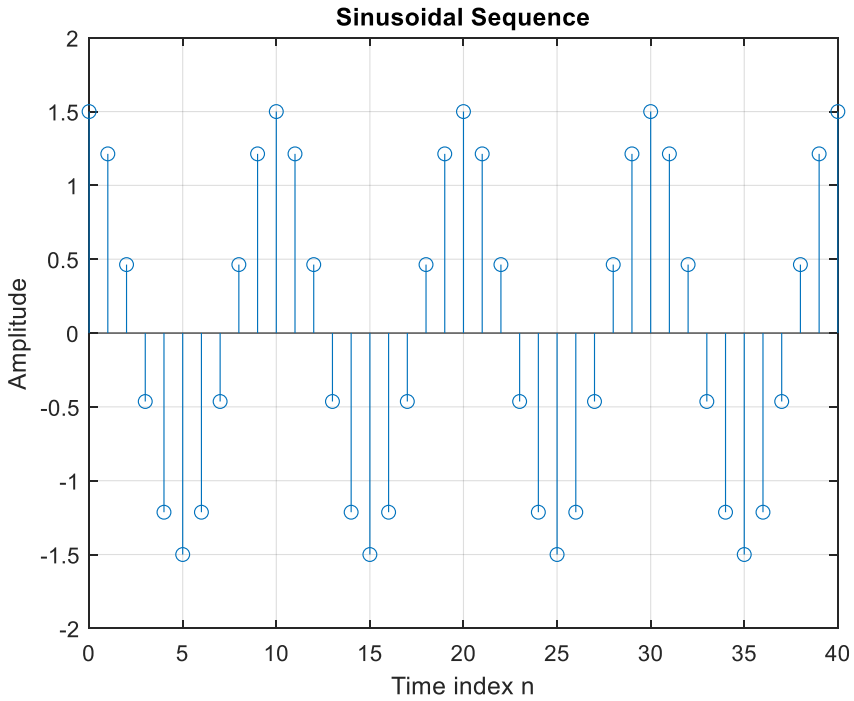
```
% Program P1_4
% Generation of a sinusoidal sequence
n = 0:40;
f = 0.9;
phase = 0;
A = 1.5;
arg = 2*pi*f*n - phase;
x = A*cos(arg);
clf;                % Clear old graph
stem(n,x);          % Plot the generated sequence
axis([0 40 -2 2]);
grid;
title('Sinusoidal Sequence');
xlabel('Time index n');
ylabel('Amplitude');
axis;
```



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

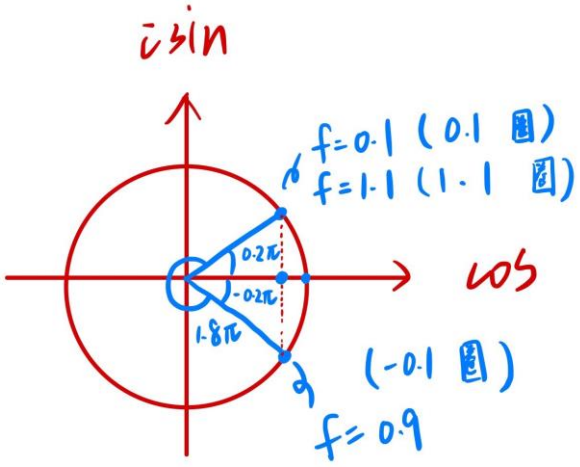
新的序列和舊序列的週期相同且振幅相同，兩圖表一致。

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



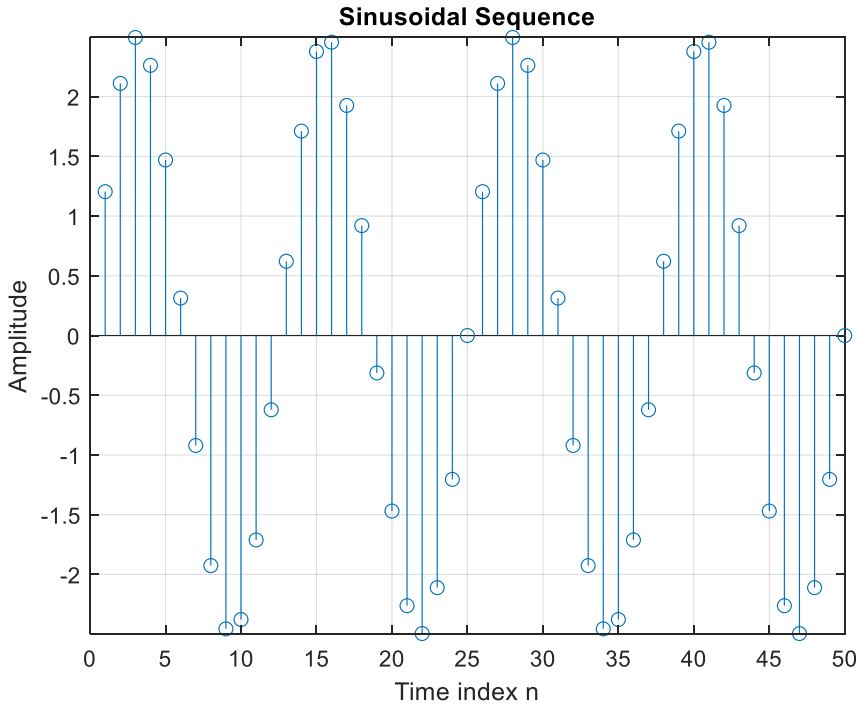
A comparison of this new sequence with the one generated in Question Q1.17 shows -

新舊序列的週期與振幅均相同，兩圖表一致。



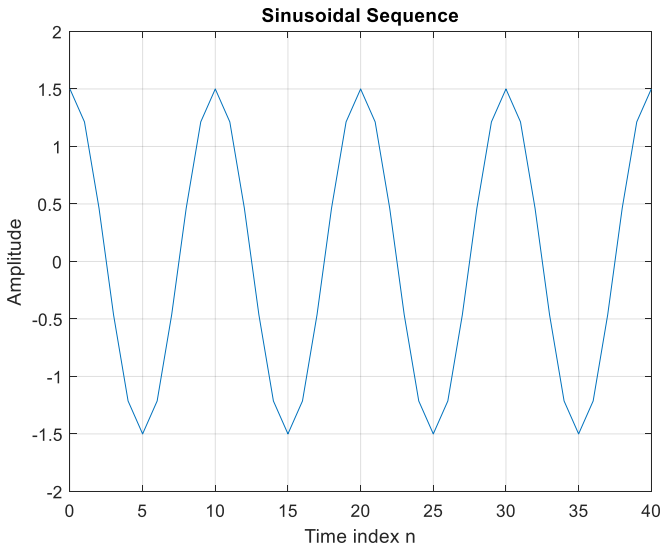
Cos 為偶函數，故 f = 0.1 與 f = 0.9 分別轉了 0.2pi 與 -0.2pi 其值相同，而 f = 1.1 轉了 2.2pi ，等同於 0.2pi，故三者圖形完全相同。

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.



The period of this sequence is – 25

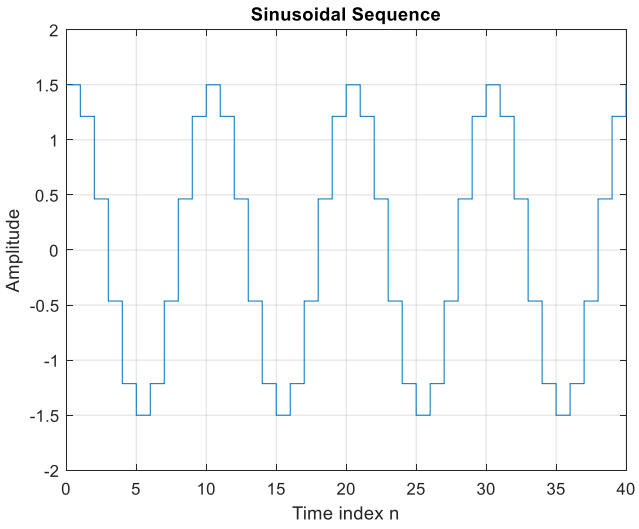
Q1.24 By replacing the `stem` command in Program P1_4 with the `plot` command, the plot obtained is as shown below:



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

"plot" command 將各點連成直線，呈現類似連續的圖形。

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



The difference between the new plot and those generated in Questions Q1.17 and Q1.24 is –

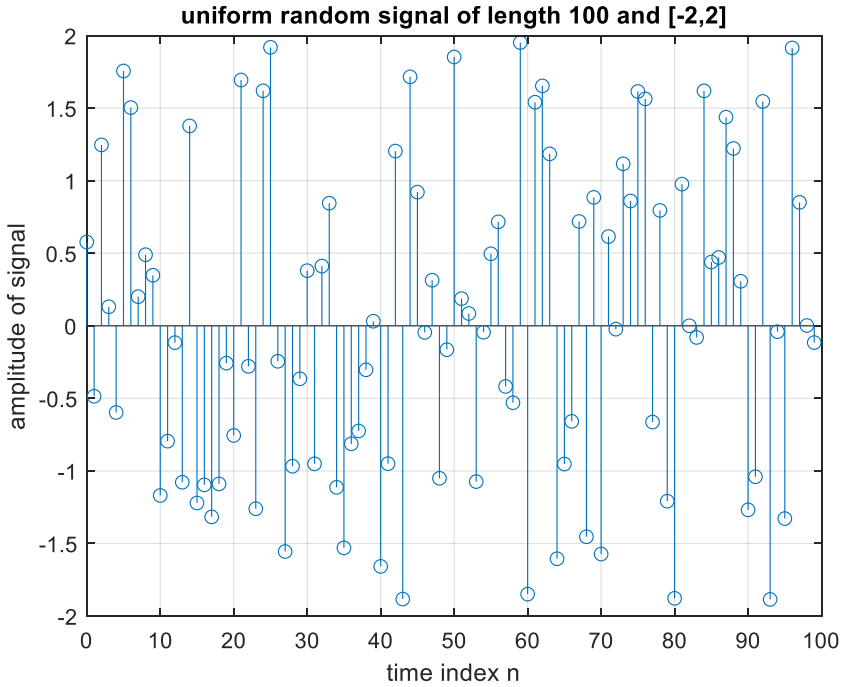
"stairs" command 維持各個離散時間點對應的 y 值，直到下個離散時間點才再次改變 y 值，呈現類似階梯的圖形。

Project 1.4 Random signals

Answers:

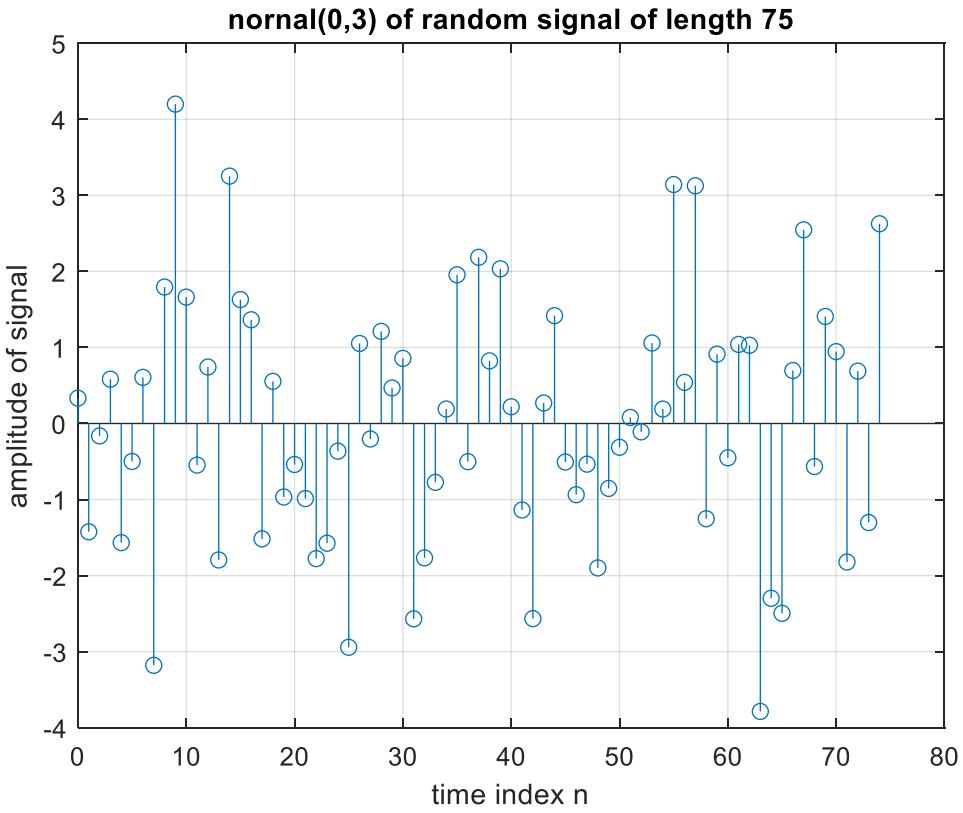
Q1.26 The MATLAB program to generate and display a random signal of length 100 with elements uniformly distributed in the interval [–2, 2] is given below along with the plot of the random sequence generated by running the program:

```
%generate a random signal

%vector of length 100
n = 0:99;
% random sigmal of length 100
s = rand(1,100); % 1*100 均勻分布於 0~1 的列向量
%change the value of signal from 0~1 to -2~2
s = (s*4)-2 ; %d 0~1 -> 0~4 -> -2~2
%清除舊有圖表
clf;
%plot the random signal
stem(n,s); %作圖
grid; %網格
title('uniform random signal of length 100 and [-2,2]'); % 圖表命名
xlabel('time index n'); %x 座標軸命名
ylabel('amplitude of signal'); %y 座標軸命名
axis;
```



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:

```
%generate a random signal nornal distribution

%vector of length 75
n = 0:74;
% random sigmal of length 75
s = randn(1,75); % 1*75 Normal(0,1)的列向量
%change the variance from 1 to 3
s = s*sqrt(3) ; % variance = sqrt(3)^2 = 3
%清除舊有圖表
clf;
%plot the random signal
stem(n,s); %作圖
grid; %網格
title('nornal(0,3) of random signal of length 75'); % 圖表命名
xlabel('time index n'); %x 座標軸命名
ylabel('amplitude of signal'); %y 座標軸命名
axis;
```

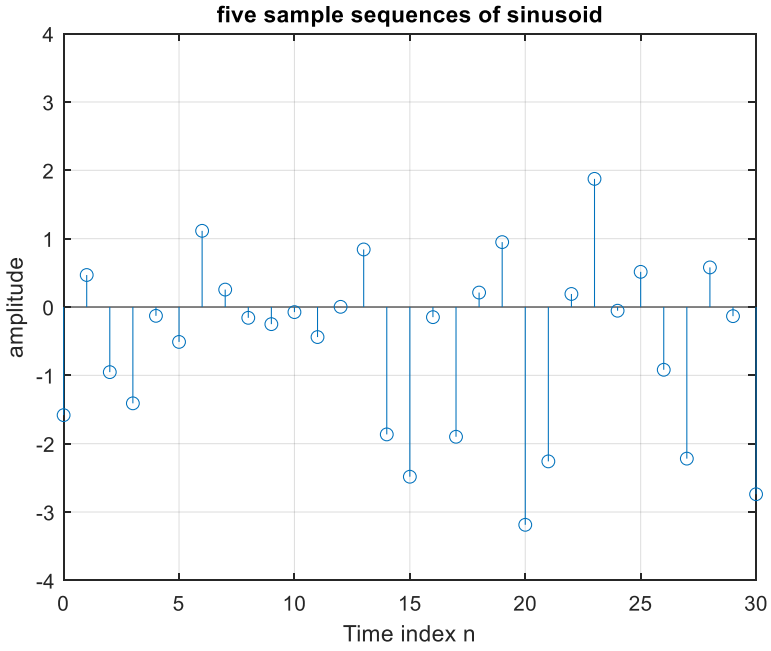


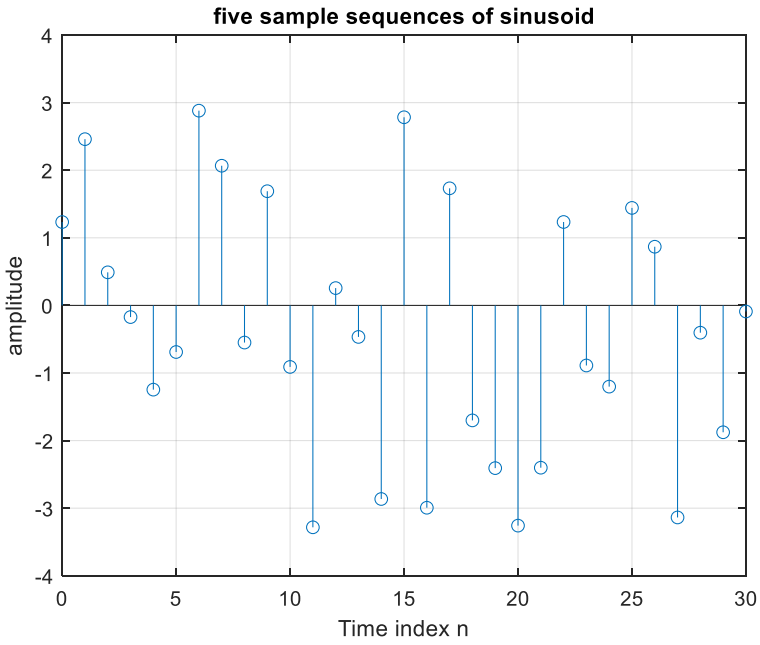
Q1.28 The MATLAB program to generate and display five sample sequences of a random sinusoidal signal of length 31

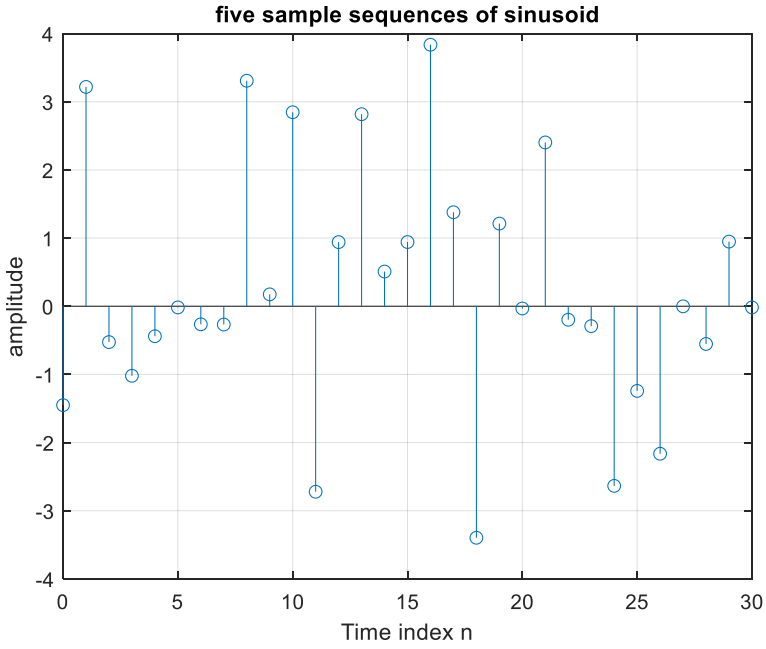
$$\{X[n]\} = \{A\cos(\omega_o n + \phi)\}$$

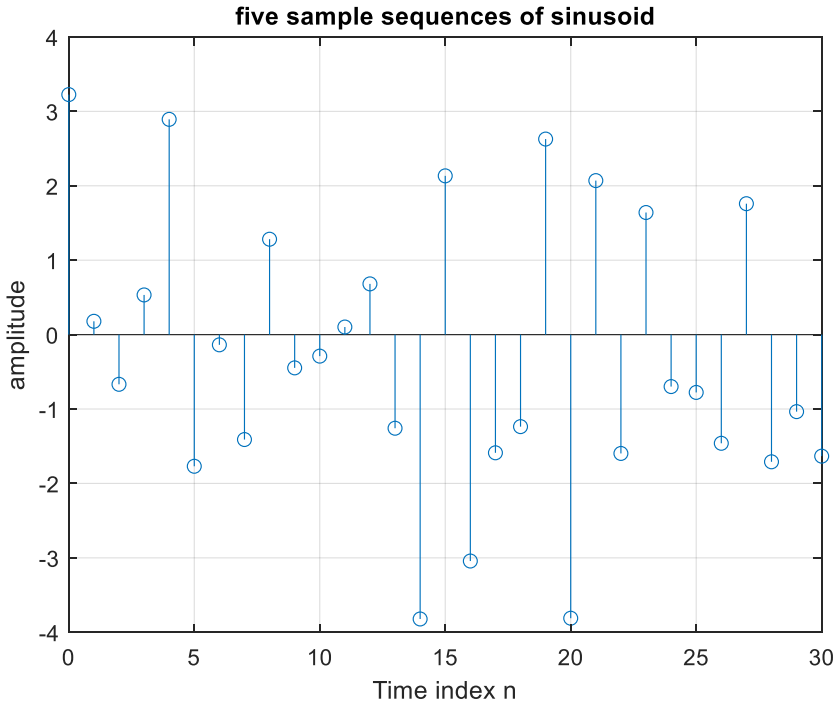
where the amplitude A and the phase ϕ are statistically independent random variables with uniform probability distribution in the range $0 \le A \le 4$ for the amplitude and in the range $0 \le \phi \le 2\pi$ for the phase is given below. Also shown are five sample sequences generated by running this program five different times.

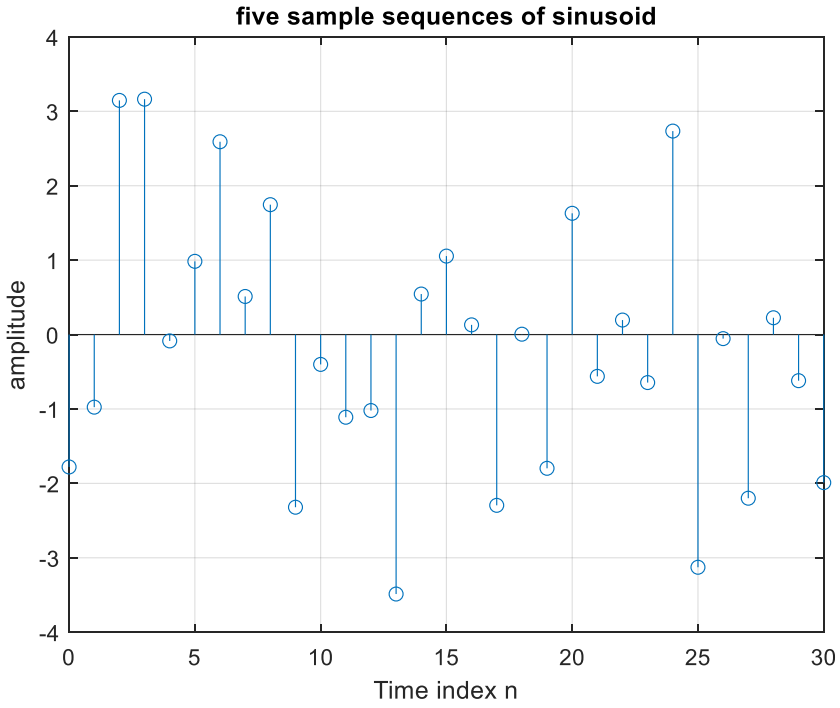
```
% random signal of random amplitude and phase

n = 0:30; % length of 31
A = rand(1,31)*4; % random amplitude from 0~4
phase = rand(1,31)*2*pi; % random phase from 0 ~ 2pi
% angle
f = 0.1 ; % assume w0 = w*pi*0.1
arg = 2*pi*f*n + phase;
% random signal generate with length of 31
x = A.*cos(arg);
clf; % 清除舊有圖表
stem(n,x); % 畫 five sample sequence 的圖
grid; % 畫網格
xlabel('Time index n');ylabel('amplitude');
title('five sample sequences of sinusoid');
axis([0 30 -4 4]);
```




five sample sequences of sinusoid
amplitude
Time index n
4
3
2
1
0
-1
-2
-3
-4
0
5
10
15
20
25
30


five sample sequences of sinusoid
amplitude
Time index n
4
3
2
1
0
-1
-2
-3
-4
0
5
10
15
20
25
30


five sample sequences of sinusoid
amplitude
Time index n
4
3
2
1
0
-1
-2
-3
-4
0
5
10
15
20
25
30


five sample sequences of sinusoid
amplitude
Time index n
4
3
2
1
0
-1
-2
-3
-4
0
5
10
15
20
25
30

1.2 SIMPLE OPERATIONS ON SEQUENCES

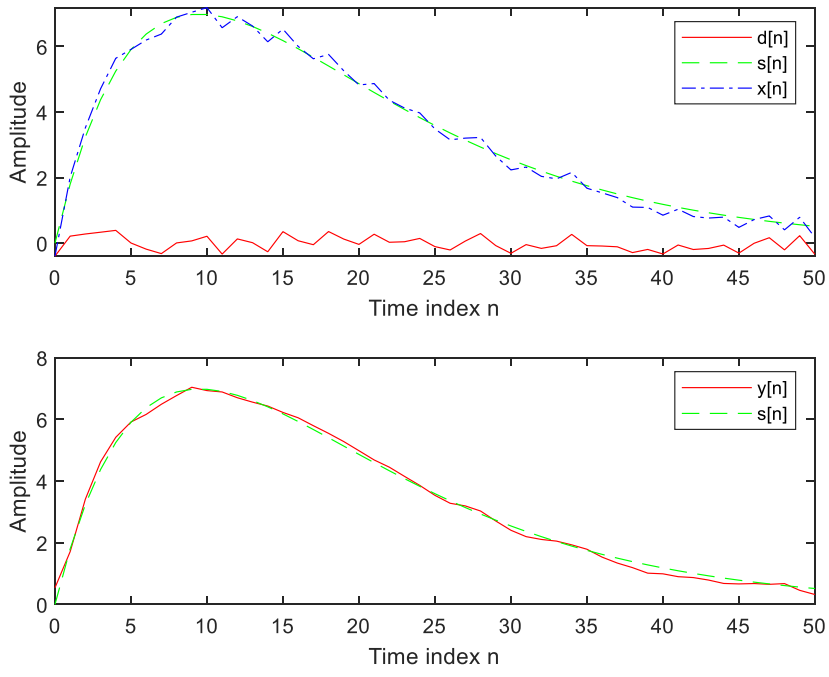
Project 1.5 Signal Smoothing

A copy of Program P1_5 is given below.

```
% Program P1_5
% Signal Smoothing by Averaging
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');
```

Answers:

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



Q1.30 The uncorrupted signal `s[n]` is - 列向量，其值隨 n 增加呈線性遞增，且亦隨 n 增加呈緩慢的指數遞減(0.9^n)

The additive noise `d[n]` is – 行向量，其 y 值為在 -0.4 到 0.4 的均勻分布

Q1.31 The statement `x = s + d` CAN / CANNOT be used to generate the noise corrupted signal because – 不行! 此題 s 為列向量 ，但 d 為行向量，兩者無法做加法運算。

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

x1 為 x 延遲 2 個 sample，x2 為 x 頭尾各補一個 0，x3 為 x 領先 2 個 sample

Q1.33 The purpose of the `legend` command is - 標示圖表中不同條線的名稱。(圖標功能)