SS Lab # 7

OBJECTIVES OF THE LAB

This lab aims at the understanding of:

- *Generating unit impulse and unit step sequences*
- *Basic signal operations*

7.1 GENERATING UNIT IMPULSE AND UNIT STEP SEQUENCES

Use Matlab commands zeros and ones to generate unit impulse and unit step sequences. These are covered in Example 1 and Example 2. Also, the unit impulse sequence is shown in Figure 7.1 and the unit step sequence is shown in Figure 7.2.

Example: Unit Impulse Sequence

```
n=-10:10;

% unit impulse
x1=[zeros(1,10) 1 zeros(1,10)];

stem(n,x1,'filled');
xlabel('sample #');
ylabel('signal amplitude');
title('Unit impulse');
axis([-10 10 -1 2]);
```

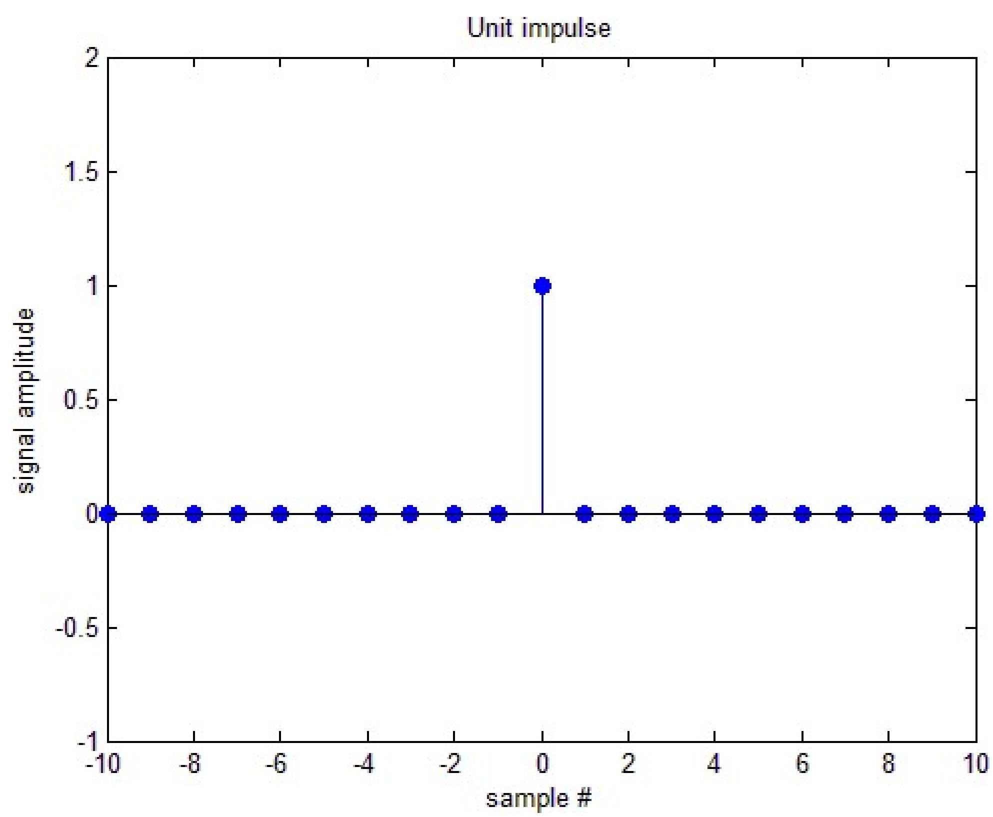

Figure 7.1 – Unit Impulse Sequence

Example: Unit Step Sequence

```
n= -10:10;

%unit step
x1=[zeros(1,10) ones(1,11)];

stem(n,x1,'filled');
xlabel('sample #');
ylabel('signal amplitude');
title('Unit step');
axis([-10 10 -1 2]);
```

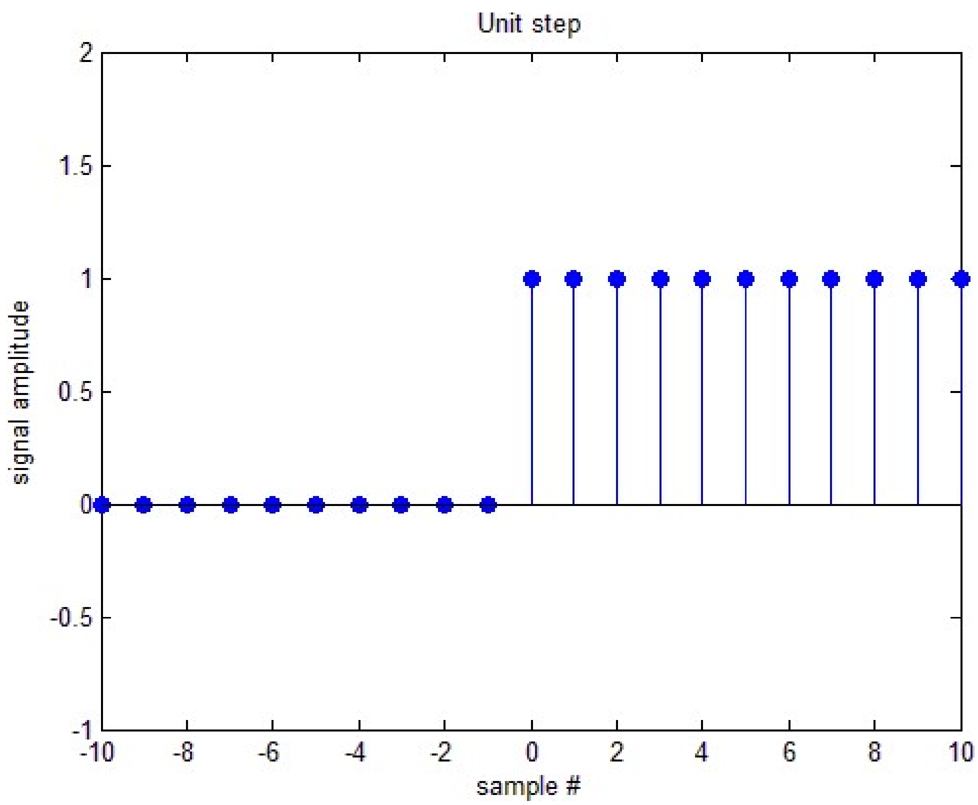

Figure 7.2 – Unit Step Sequence

--------------------------TASK 01-------------------------

Using **ones** function, plot the **signum** sequence over interval $-10 \le n \le 10$. It can be defined as:

$$\text{sign}(n) = \begin{cases} 1, & \text{for } n > 0 \\ -1, & \text{for } n < 0 \\ 0, & \text{for } n = 0 \end{cases}$$

--------------------------TASK 02-------------------------

Prove the following:

$$\delta[n] = u[n] - u[n-1]$$

7.2 BASIC SIGNAL OPERATIONS

There are different operations that can be performed on the signals such as time shifting, flipping, amplitude scaling, time scaling, amplitude clipping, and signal replication. These are shown in Figure 7.3 to Figure 7.8 respectively.

1) Signal Shifting

```
clc
clear all
close all

n=0:0.002:4;
x=sin(2*pi*1*n);

subplot(2,1,1);
plot(n,x,'linewidth',2);
title('Original Signal');
xlabel('Time');
ylabel('Signal Amplitude');
axis([-3 4 -1 1]);
grid;

subplot(2,1,2);

plot(n-1,x,'linewidth',2);
title('Advanced signal');
xlabel('Time');
ylabel('Signal Amplitude');
```

axis([-3 4 -1 1]);

grid;

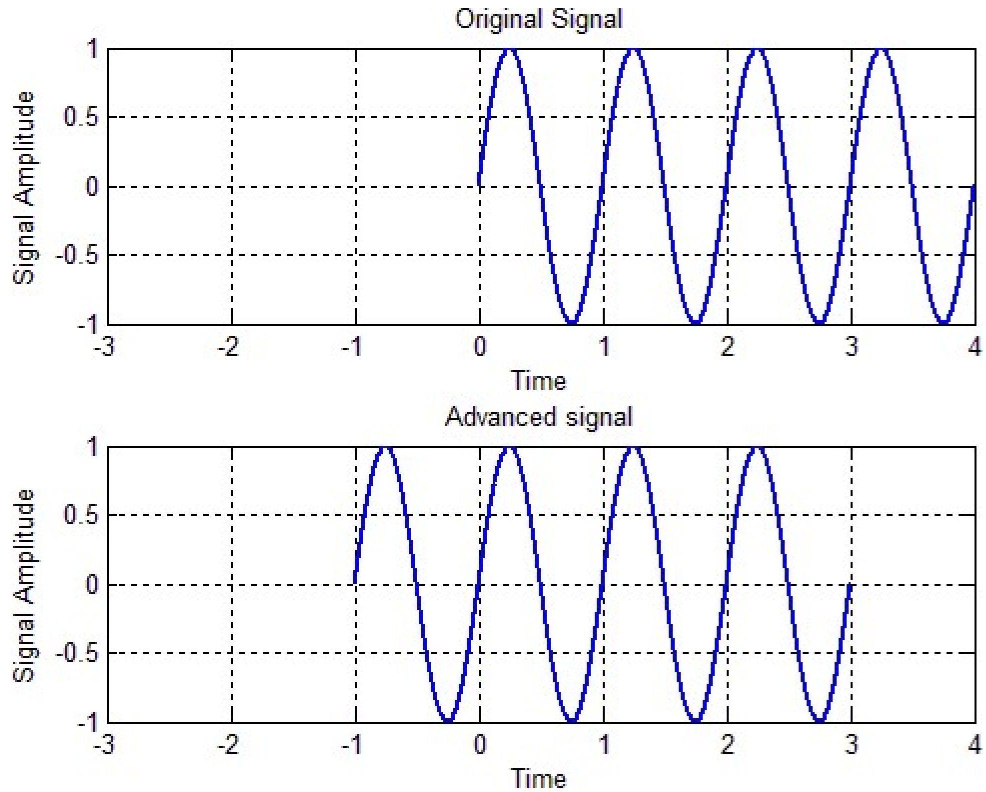

Figure 7.3 – Signal Shifting

-------------------------TASK 03-----------------------

Delay the **original signal** given in above example by 1 sec. Plot both the delayed & original signal on the same figure.

2) Signal Flipping

clear n=-

1:1/1000:1;

x1=5*sin(2*pi*1*n);

subplot(2,1,1);

plot(n,x1, 'g', 'linewidth',2);

axis([-1 1 -5 5]);

xlabel('time');

ylabel('signal amplitude');

```
title('Original sine wave');
grid;

subplot(2,1,2);
plot(-n,x1, 'r', 'linewidth',2);
axis([-1 1 -5 5]);
xlabel('time');
ylabel('signal amplitude');
title('Flipped sine wave');
grid;
```

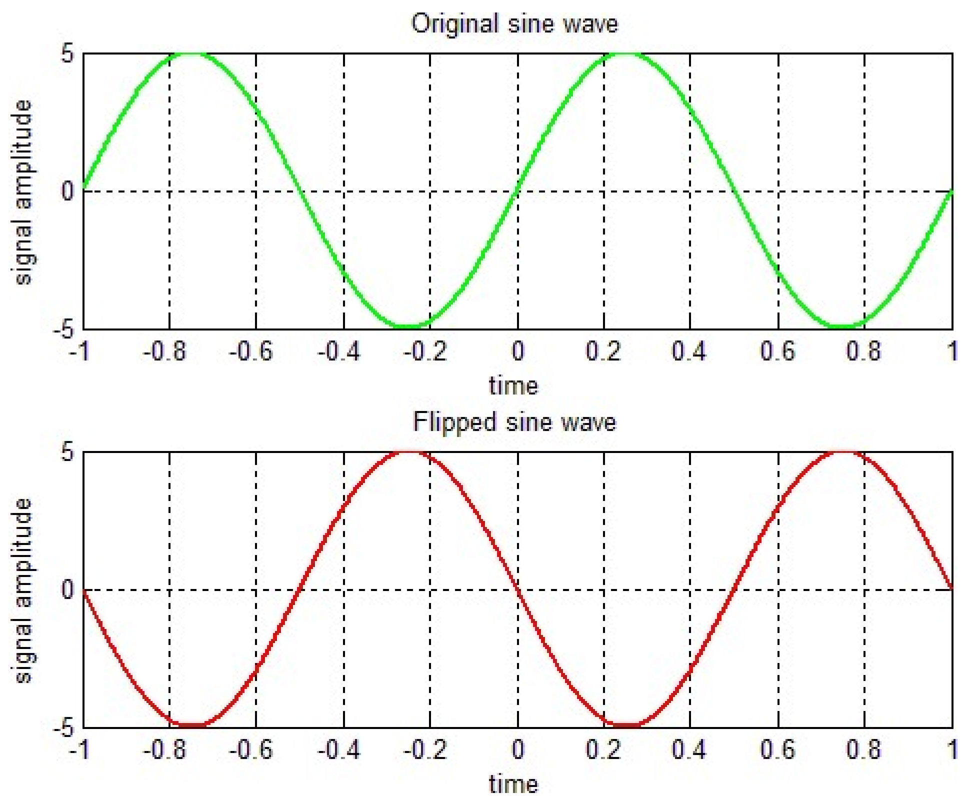

Figure 7.4 – Signal Flipping

---------------------------TASK 04-------------------------

Flip the following signal:

$$y = 5 \exp\left(i * n * \frac{\pi}{4}\right)$$

Plot the original signal as well as the flipped one in the same figure.

---------------------------TASK 05--------------------------

Flip the following signal:

$$x[n]= 2\delta[n]+ 5\delta[n-1] + 8\delta[n-2] + 4\delta[n-3] + 3\delta[n-4]$$

Plot the original signal as well as the flipped one in the same figure.

3) Amplitude Scaling

```
clear
n=1:7;
 x=[1 2 2 3 2 2 1];

subplot(2,1,1);
stem(n,x, 'filled');
title('Original signal');
xlabel('Time index');
ylabel('Signal Amplitude');
axis([1 7 0 4]);
grid;

S=2;
subplot(2,1,2);
stem(n,S*x, 'filled');
title('Amplitude Scaled signal');
xlabel('Time index');
ylabel('Signal Amplitude');
axis([1 7 0 8]); grid;
```

---------------------------TASK 06--------------------------

Scale the continuous-time sinusoid used in signal shifting example by a factor of 2.

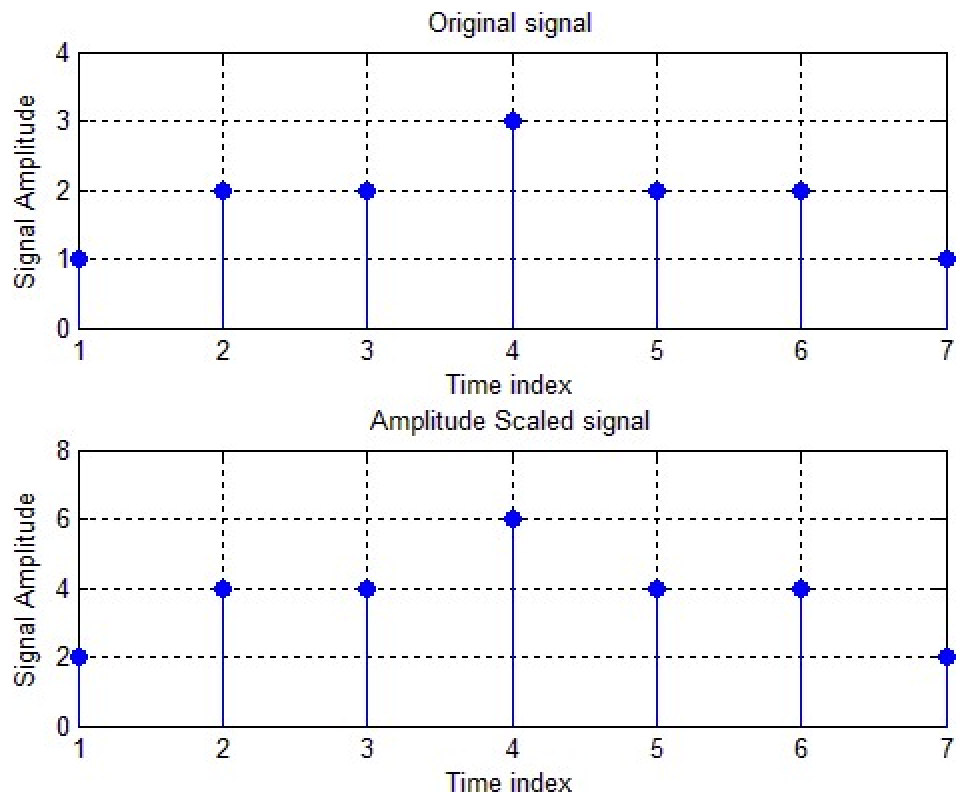

Figure 7.5 – Amplitude Scaling

4) Time Scaling

```
%Decimation (down-sampling)
clear

n=-2:1/1000:2;
x1=sin(2*pi*2*n);
x2=decimate(x1,2);

subplot(2,1,1);
plot(x1);
title('Original signal');
xlabel('Sample Number');
ylabel('Signal Amplitude');
```

```
axis([0 4000 -1 1]);
grid;

subplot(2,1,2);
plot(x2);
title('Decimated signal');
xlabel('Sample Number');
ylabel('Signal Amplitude');
axis([0 2000 -1 1]);
grid;
```

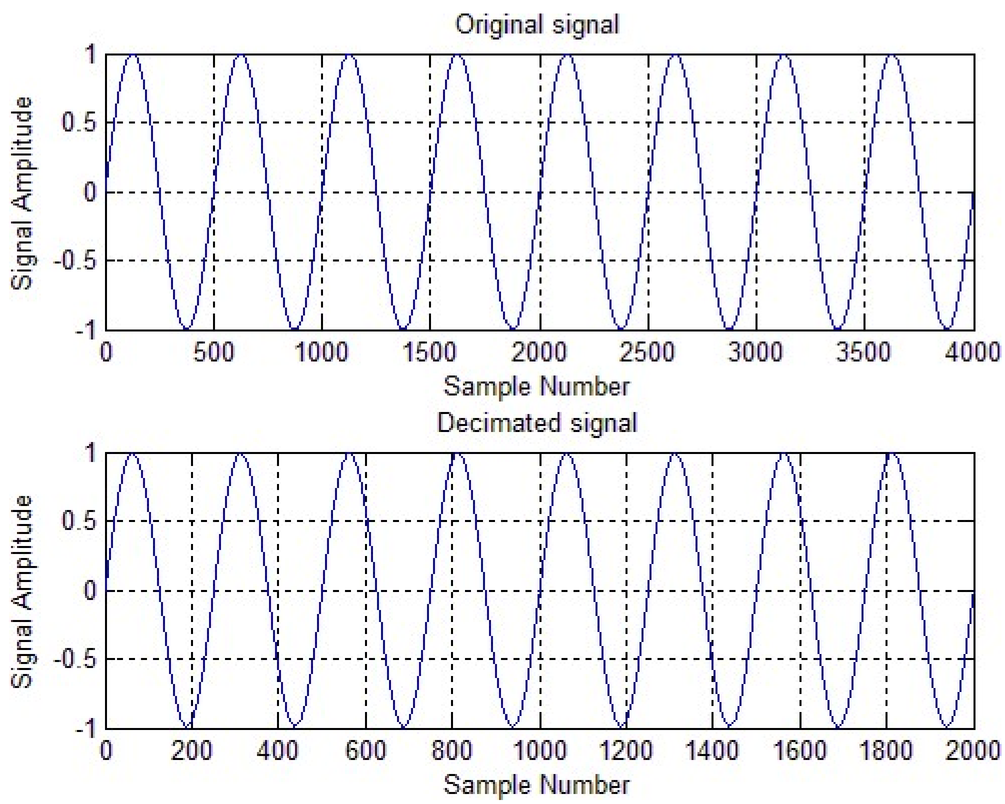

Figure 7.6 – Time Scaling

-------------------------TASK 07-------------------------

Use ***interp*** command in the above program to interpolate (up-sample) the signal by a factor of 2.

5) Amplitude Clipping

```
clear
x=[3 4 4 2 1 -4 4 -2];
len=length(x);
y=x;
hi=3;
lo=-3;
for i=1:len
        if(y(i)>hi)
                y(i)=hi;
        elseif(y(i)<lo)
                y(i)=lo;
        end
end

subplot(2,1,1);
stem(x,'filled');
title('original signal');
xlabel('Sample number');
ylabel('Signal Amplitude');

subplot(2,1,2);
stem(y,'filled');
title('Clipped Signal');
xlabel('Sample number');
ylabel('Signal Amplitude');
```

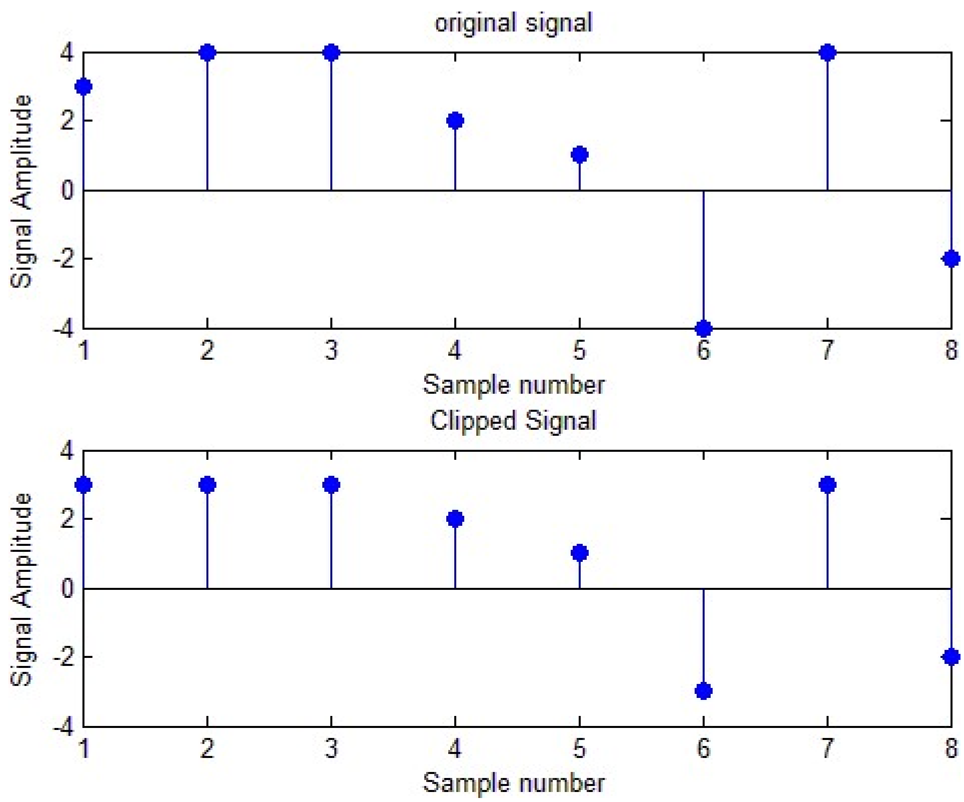

Figure 7.7 – Amplitude Clipping

6) Signal Replication

```
clear
x=[1 2 3 2 1];
y=[x x x x];
subplot(2,1,1);
stem(x,'filled');
title('Original Signal');
xlabel('Sample Number');
ylabel('Signal Amplitude');
axis([1 20 0 3]);
grid;

subplot(2,1,2);
stem(y,'filled');
title('Replicated Signal');
```

```
xlabel('Sample Number');
ylabel('Signal Amplitude');
axis([1 20 0 3]);
grid;
```

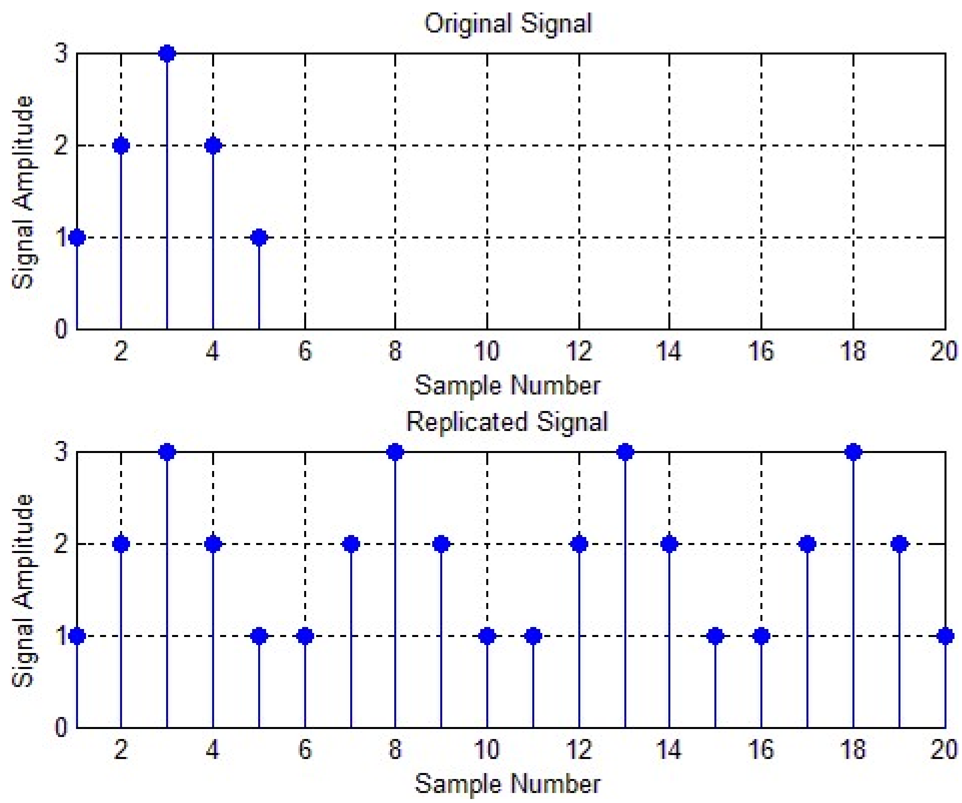

Figure 7.8 – Signal Replication