Lab # 6

Domain Operations on Signals (Time Shifting, Time Scaling)

Objective:

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Introduction:

A signal is classified with respect to its domain and range. Similarly operations on signals are classified into two categories.
1. Operations on domain
2. Operations on Range

Operations on Domain

Domain operations are those which involve time axis or integer axis as main focus of operations. Domain operations are classified into following four categories.
1. Time Shifting
2. Time Scaling
3. Time Reversal
4. Sampling

1. Time Shifting

Time Shift or delay operation shifts the signals to the desired delay. Given a signal $x(t)$, a shifted signal will be of the form $y(t) = x(t - to)$ where *to* is the delay or shift in time domain. Let **Asin(2π ft)** is the signal which is desired to be shifted by an amount *to* .

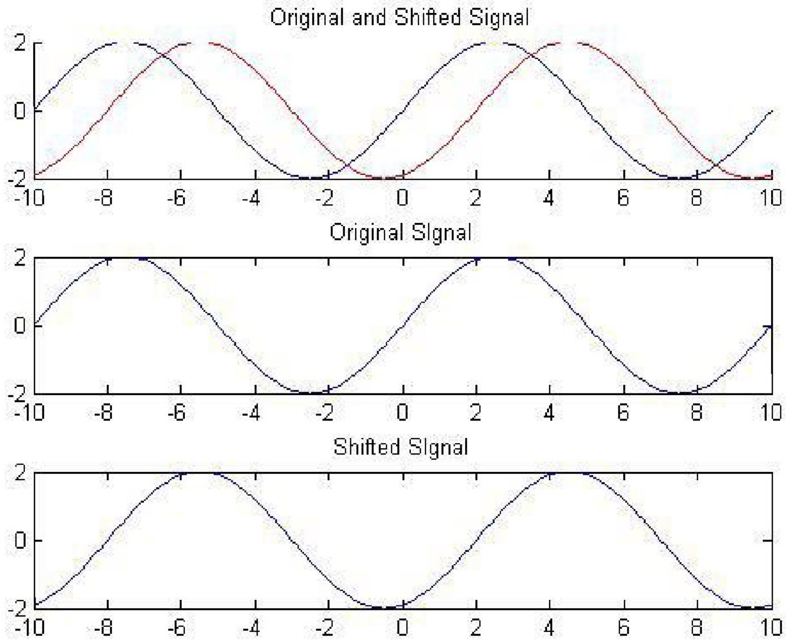
a) **Shifts the wave form to the right**
$y(t) = x(t - to)$

b) **Shifts the wave form to the left**
$y(t) = x(t + to)$

Here is the Matlab code for it.

```
% Time Delay/ Time Shifting
```

```
t=-10:0.1:10;
f=0.1;
t0=2;                           % Shift Units
a=2;                            % Amplitude
x=a*sin(2*pi*f*t);
y=a*sin(2*pi*f*(t-t0));
subplot(3,1,1);
hold on;
plot(t,x);
plot(t,y,'r');
title('Original and Shifted Signal');
subplot(3,1,2);
plot(t,x);
title('Original SIgnal');
subplot(313);
plot(t,y);
title('Shifted SIgnal');
```



For discrete signal each sample of $x(n)$ is shifted by an amount k to obtain the shifted sequence

$y(n)$.

$$y(n) = \{x(n - k)\}$$

If we let $m = n - k$ then $n = m + k$ and we get

$y(m + k) = \{x(m)\}$

Matlab code for the function of time shift operation is as follows:

```
function [y,n]=sigshift(x,m,n0)
n=m+n0;
y=x;
```

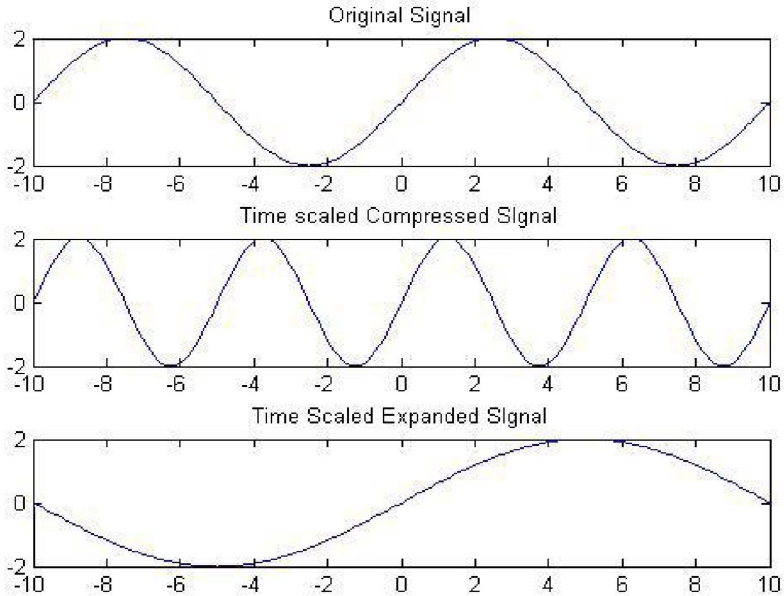
2. Time Scaling

Operation of time scaling scales the time axis to a certain scale resulting in increasing or decreasing the frequency of the signal which compresses or expands the signal on time domain. General expression for the time scaled output is given below.

$y(t) = x(\alpha\, t)$

Let **Asin(2π ft)** is the original signal on time scale. We scale the *t* domain by amount alpha and beta. Alpha scaled signal will be compresses due to increment in frequency while beta scaled signal will be expanded. Exampled is coded below.

```
% Time Scaling
t=-10:0.1:10;
f=0.1;
alpha=2;                    % Compression Units
a=2;                        % Amplitude
beta=0.5;                   % Expansion units
x=a*sin(2*pi*f*t);
y=a*sin(2*pi*f*(alpha*t));
z=a*sin(2*pi*f*(beta*t));
subplot(311);
plot(t,x);
title('Original Signal');
subplot(312);
plot(t,y);
title('Time scaled Compressed SIgnal');
subplot(313);
plot(t,z);
title('Time Scaled Expanded SIgnal');
```



Original Signal
Time scaled Compressed SIgnal
Time Scaled Expanded SIgnal
2
0
-2
-10
-8
-6
-4
-2
0
2
4
6
8
10

Post Lab Questions

a) **What is Time Shifting?**

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b) **What are different categories of operations on domain?**

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c) **Differentiate between time shifting and time scaling.**

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Lab Tasks

Task 1

Perform Time Shifting operation (Time Delay, Time Advance) on the given signal:

$$A = \sin 2\pi f t$$

Task 2

Perform Time Scaling operation (Compression and Expansion) on the given signal:

$$A = \sin 2\pi f t$$