Lab # 8

Range Operations on Signals

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

Range operations involve amplitudes of the signal as major focus of operations. They are classified as

1. Amplitude Scaling
2. Addition of Signals
3. Subtraction of signals
4. Multiplication of Signals
5. Derivative of signals

1. Amplitude Scaling

Amplitude scaling rescales the amplitude of the signal. As a result signal may be amplified or attenuated. Given a signal $x = A\sin(2\pi ft)$ where A is the amplitude of the signal.

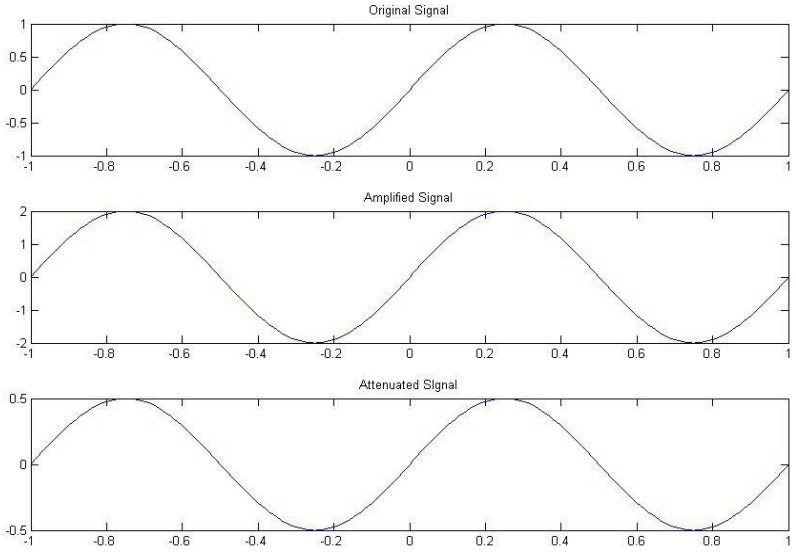
We can rescale the amplitude by some constant multiplier alpha or beta. Amplitude scaled output will be

$$y = \alpha\{A\sin(2\pi ft)\}$$

Code given below scales the amplitude by constant alpha and beta which amplifies and attenuate the signal respectively.

```
% Amplitude Scaling
t=-1:0.01:1;
f=1;
a=1; % Amplitude
alpha=2; % Amplitude scale
beta=0.5; % Attenuated scale
x=a*sin(2*pi*f*t);
```

```
y=alpha*sin(2*pi*f*t);
z=beta*sin(2*pi*f*t);
subplot(3,1,1);
plot(t,x);
title('Original Signal');
subplot(3,1,2);
plot(t,y);
title('Amplified Signal');
subplot(3,1,3);
plot(t,z);
title('Attenuated SIgnal');
```



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2. Signal Addition

This is a sample by sample addition given by

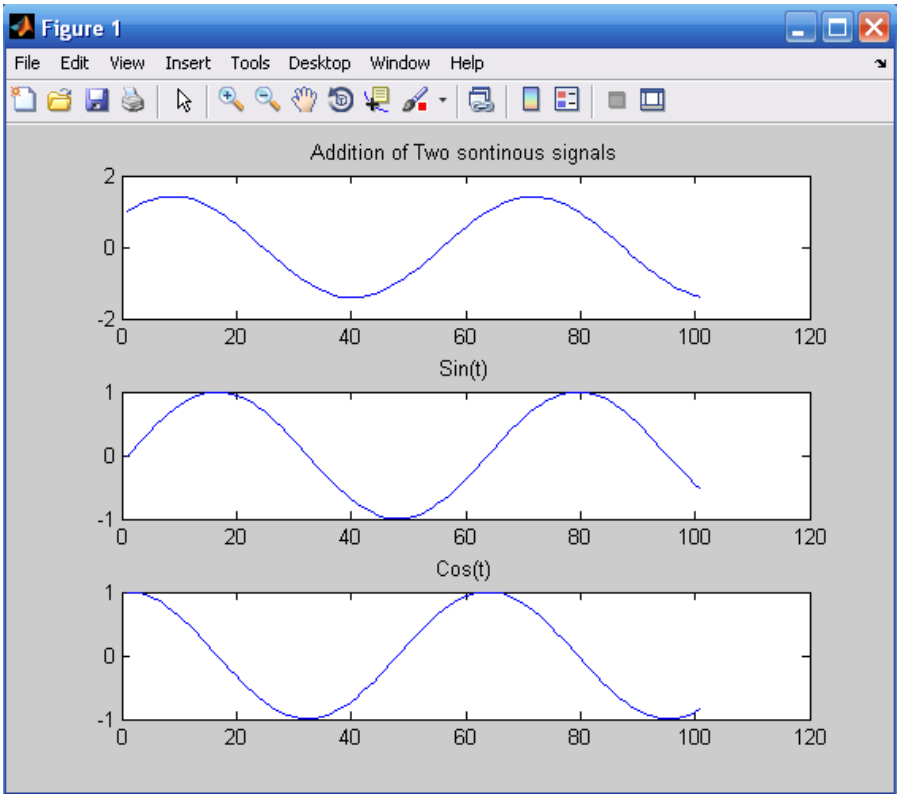
$\{x1(n)\}+\{x2(n)\} = \{x1(n) + x2(n)\}$ Discrete

$\{x1(t)\}+\{x2(t)\} = \{x1(t) + x2(t)\}$ Continous

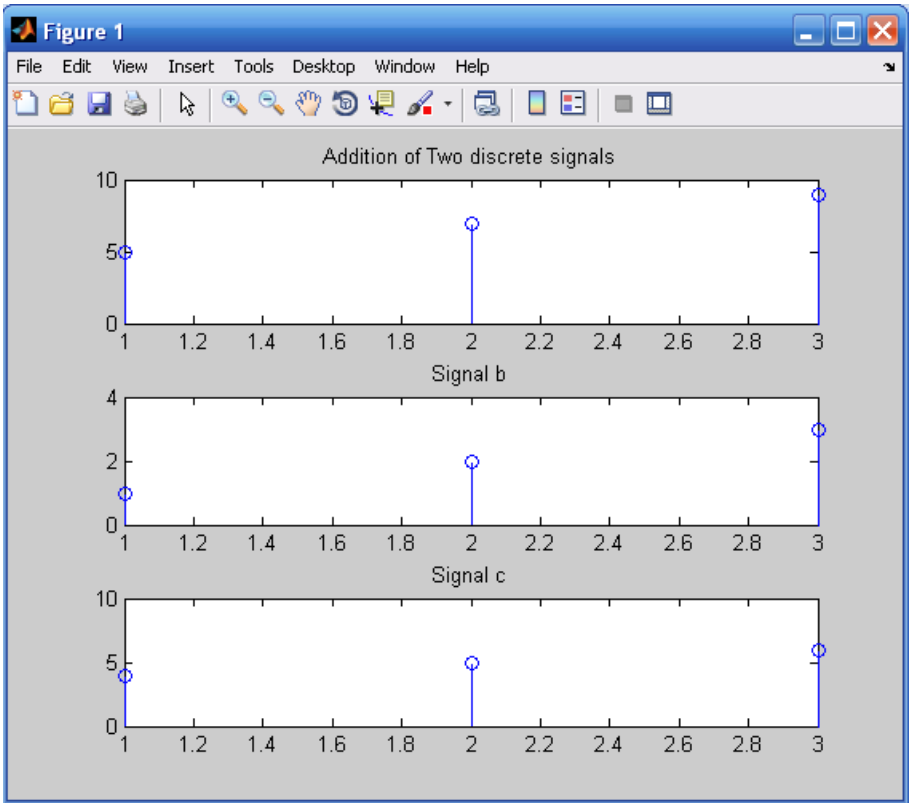
It is implemented in Matlab using + operator however this requires the lengths of the vectors to be same.

```
% Addition of continuous signals
t=0:0.1:10;
a=sint(t);
```

```
b=cos(t);
c=a+b;
subplot(3,1,1)
plot(c) ;
subplot(3,1,2);
plot(a);
subplot(3,1,3);
plot(b);
```




```
% Addition of discrete signals
b=[1 2 3];
c=[4 5 6];
d=b+c;
subplot(3,1,1)
stem(c) ;
subplot(3,1,2);
stem(a);
subplot(3,1,3);
stem(b);
```



3. Signal Subtraction

Sequence/Signals subtraction is similar to addition of signals except the function name and operator sign.

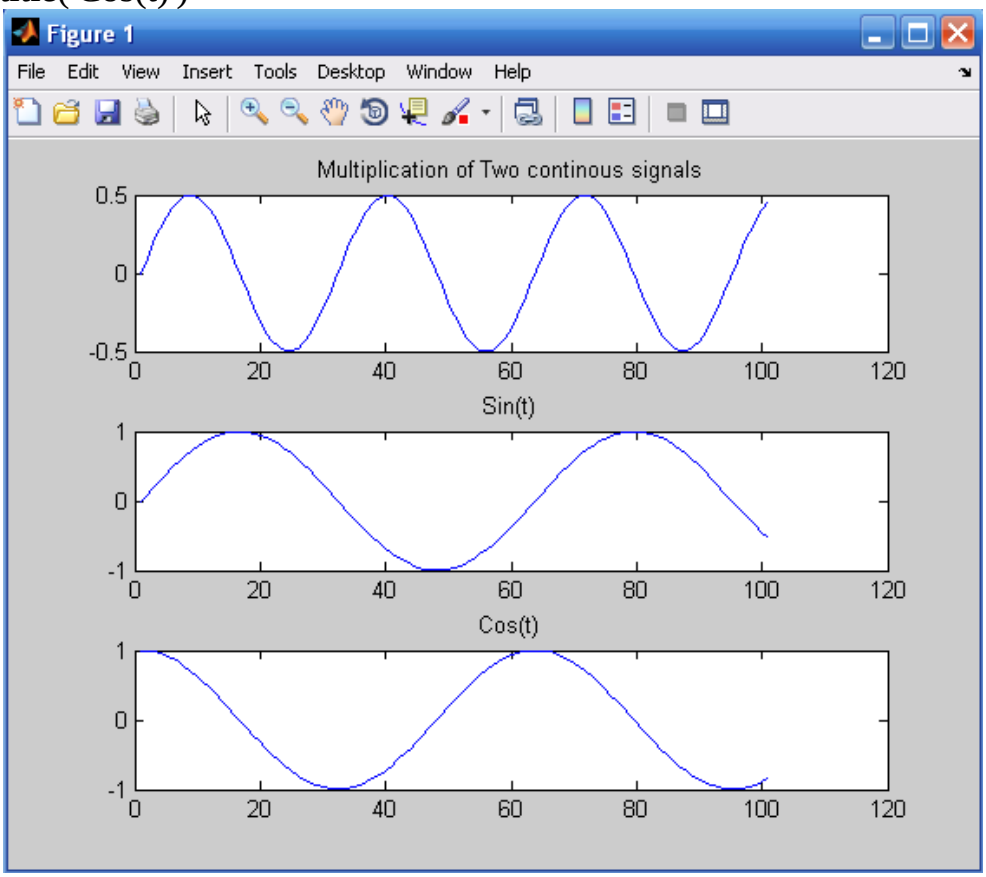
4. Signal Multiplication

Multiplication of signals or sequences involves sample by sample multiplication. After making the lengths of the vectors same, we multiply the signals using '.' (dot) operator.
Here is the example.

```
% Multiplication of sgnals
t=0:0.1:10;
a=sin(t);
b=cos(t);
c=a.*b;

subplot(3,1,1)
plot(c) ;
```

```
title('Multiplication of Two continous signals')
subplot(3,1,2);
plot(a);
title('Sin(t)')
subplot(3,1,3);
plot(b);
title('Cos(t)')
```

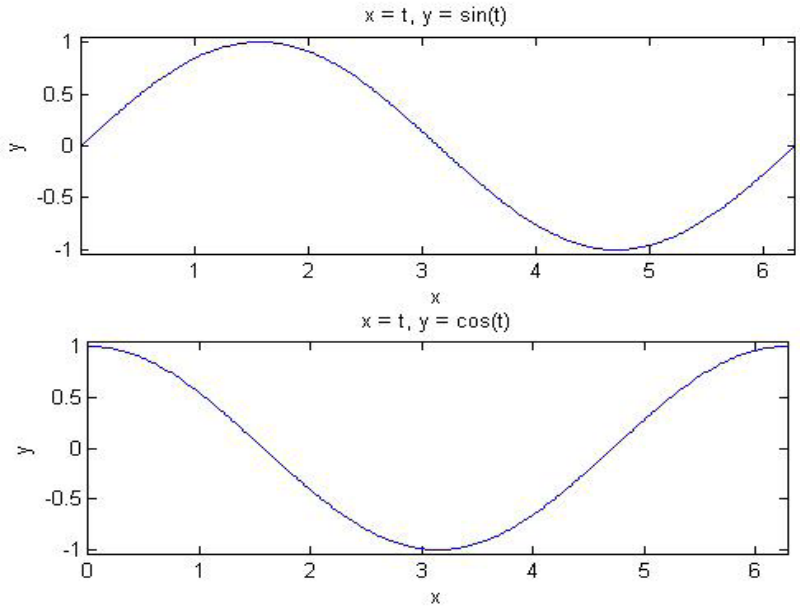


5. Derivative of Signal

Derivative of a given signal is calculated using symbolic Mathematics. Following is the example to find the derivative of the signal.

```
%Derivative of signal
syms x y t f
x=sin(t);
y=diff(x);
subplot(2,1,1);
ezplot(t,x);                    %command to plot in syms mode
subplot(2,1,2);
```

ezplot(t,y);



Post Lab Questions

a) **What are the operations that can be done on range of a signal?**

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b) **What is 'syms' used for?**

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c) **What is the condition on which two signals can be added or subtracted?**

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d) **Explain how do we find derivative of a signal.**

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Lab Tasks

Task 1

a) Generate a continuous signal and perform amplitude scaling operation on it. Scale the amplitude by using constants
- alpha =Last digit of your student ID
- beta =1/Last digit of your student ID.

b) Find Derivative of **cos(t)** in Matlab.

Task 2

a) Write a Matlab code for any two signals of your choice which returns the following output on graph simultaneously.
   a. Sum of the signals
   b. Difference of the signals

c) Write a Matlab code to find product of the following signals:

i. a=sin(2+5t) , b=e^{10-t}
ii. a=cos(6t) , b=e^{6-t}
iii. a=e^{3t-1} , b=e^{2t};