Time and Amplitude Operations on Continuous Time Signals

This experiment is intended to make the student to use MATLAB for experiments, relating to time and amplitude operations on continuous time signals. It is expected that the student will write a "readable" code in a file and execute. Use only **Editor window** to write the Matlab Code.

The student is expected to be conversant with Matlab commands: axis, text, grid, hold on, hold off, clc, clear all, close all, zeros, ones, etc.

In all these experiments, the time scale (x-axis) should have a resolution of 1 msec. Use Example 1 for creating such time axis.

```
%--------------Example 1----------------------
% Time axis for signals
dt = 0.001;                 % Time axis resolution 1 msec
Stime = -5 ;                % Start Time of the time axis. In this example it is -5 seconds
Etime = 5;                  % End time of Time axis. In this example it is 5 seconds
Mytime = [Stime:dt:Etime];  % Total time axis

% You may change the Stime and Etime as per the need.
```

Further, usually we may intend to define or display a signal over certain time duration, say between *t1* and *t2 seconds* even though the signal may exists beyond these limits. To facilitate this, **windowing** of the signals is used. You may use the following code snippet for **windowing** of signals.

```
%--------------Example 2----------------------------------
% Windowing of signals using relational operators
% let signal x is defined for  (Stime ≤ t ≤ Etime) and we want to restrict it from Ltime to Utime
Stime = 0;                  % Start Time of the signal. In this example it is 0 seconds
Etime = 5;                  % End time of the signal. In this example it is 5 seconds
Ltime = 1;                  % lower time limit of the signal. In this example it is 1 second
```

```
Utime = 3;                    % upper time limit of signal . In this example it is 3 seconds


Stime=0; dt=0.01; Etime=5;
t = [Stime:dt:Etime];
x=exp(-2*t)            % Expression of given signal (x)
ltime = 1;             % lower Time limit of the windowed signal. In this example it is 1 seconds

utime = 3;             % upper Time limit of the windowed signal. In this example it is 3 seconds

y=x.*(t>=Ltime & t<Utime)          % Expression for windowed signal between  Ltime and Utime

% You may change the Ltime and Utime as per the need.

%----------------------------------------------------------------------------------------------------------------------
```

A. Windowing of given signals:

a. Write the expression for a sine wave signal of frequency 0.5 Hz, starting at time = -5 sec and ending at time = 10 seconds and reaching V_{max} = 2 volts.
b. Draw the above signal in your note book.
c. Generate the same sine wave signal, with a time resolution of 1 milli seconds time axis, using matlab code and plot using blue color, showing the time and amplitude scales and name it as signal x(t).
d. Let y(t) = 3+ x(t) for ($0 \leq t \leq 4$), draw y(t) in your note book on the same plot where you have drawn x(t).
e. Generate the windowed y(t) using matlab and plot, overlying on the same plot of x(t), using red color. Note here the windowing effect, when you draw y(t) using the same time axis scale on which you have drawn x(t). Show the time scale and labels. Index the plots using "text" command.
f. Use **axis** command to capture time axis between -5 and 12 seconds and signal amplitudes between -2 and +8 Volts.
g. Use the **grid** command to show the grid properly.

B. Time Shifting operation on a Signal:

Consider the signal $x(t) = 1+ t$ for $(2 \leq t \leq 5)$

a. Sketch x(t) in your note book.
b. Choose the time axis between -5 to + 12 seconds at a resolution of 1 msec.
c. Generate x(t) in matlab and plot, using color blue and showing the time axis and labels.
d. Let y(t) be a signal obtained by delaying x(t) by 4.25 seconds. Write the expression and sketch y(t) in your note book
e. Generate y(t) and plot, overlying on the plot for x(t), using red color. Show the time scale and labels. Index the plots using "text" command.
f. Let z(t) be a signal obtained by advancing x(t) by 4.25 seconds. Write the expression and sketch z(t) in your note book
g. Generate z(t) and plot, overlying on the earlier plot, with x(t) and y(t), using green color . Show the time scale and labels. Index the plots using "text" command.
h. Use axis command to capture time axis between -5 and 12 seconds and signal amplitudes between -2 and +8 Volts.
i. Use the grid command to show the grid properly.
h. Verify your plots drawn in (a), (d) & (f) with the Matlab generated plots in (g).

C. Time Scaling operation on a Signal:

Consider the signal $x(t) = e^{-0.3t}$ for $(0 \leq t \leq 2)$

a. Sketch x(t) in your note book.
b. Choose the time axis between -10 seconds to + 10 seconds at a resolution of 1 msec.
c. Generate x(t) using matlab and plot. Use blue colour and show the time axis and labels.
d. Consider the time compressed signal y(t) = x(2t). Write the expression and sketch y(t) in your note book.
e. Generate y(t) and plot, overlying on the plot for x(t), with red color. Show the time scale and labels. Index the plots using "text" command.
f. Consider the time expanded signal z(t) = x(t/2). Write the expression and sketch z(t) in your note book.

g. Generate z(t) and plot, overlying on the earlier plot, with x(t) and y(t), using green color. Show the time scale and labels. Index the plots using "text" command.

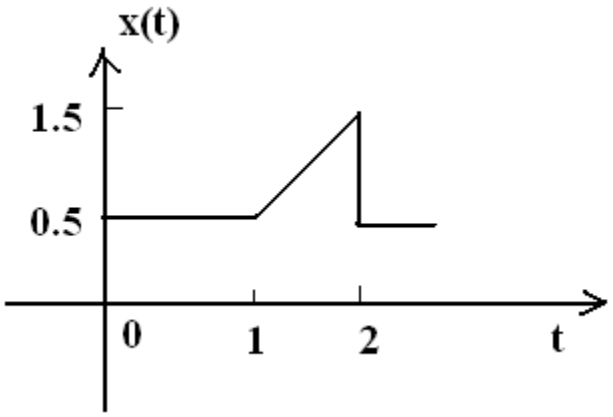
j. Use axis command to capture time axis between -2 and 8 seconds and signal amplitudes between -2 and +2 Volts.

k. Use the grid command to show the grid properly.

h. Verify your plot in (a), (d) & (f) with Matlab generated plots in (g).

D. Time and Amplitude Folding operation on Signal:

Consider the signal in the figure below.



a. Write the expression for the given signal x(t) in your notebook in the time limit ($0 \leq t \leq 2$)

b. Choose the time axis between -4 seconds to + 4 seconds at a resolution of 1 msec.

c. Generate x(t) and plot, using color blue and showing the time axis and labels.

d. Consider the time folded signal y(t) = x(- t) . Sketch y(t) in your note book.

e. Generate y(t) and plot, overlying on the plot for x(t), using red color. Show the time scale and labels. Index the plots using "text" command.

f. Consider the amplitude folded signal z(t) = - x(t). Sketch z(t) in your note book

g. Generate z (t) and plot, overlying on the earlier plot, with x(t) and y(t), using green color . Show the time scale and labels. Index the plots using "text" command.

h. Use axis command to capture time axis between -4 and 4 seconds and signal amplitudes between -2 and +2 Volts.

i. Use the grid command to show the grid properly.

j. Verify your plot in (a), (d) & (f) with Matlab generated plots in (g).

k. Observe whether the plots for x(- t) and - x(t) are same or not. Give suitable comments.