Sanuj Shakya
IoE, Pulchowk Campus

Lab Module 1

Initial report must include MATLAB programs for each of the problems given below. The graphical representation of each signal must be included in the final report along with necessary discussions. Use *xlabel ()*, *ylabel ()* and *title ()* commands to label the axes and add title to each graph.

Use *help* command in MATLAB command window to understand the use of different MATLAB operators and functions used in this module (e.g. *help plot*).

Section A

Continuous Time and Discrete Time Signals

Using MATLAB for signal generation and plotting

MATLAB (MATrix LABoratory) is a numerical computing environment that allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, etc.

In this course, we use MATLAB for generation and graphical visualization of CT and DT signals over a time interval. To generate a signal in MATLAB, first define the time interval as a single dimensional array. Then define another variable (array) to store the values of the signal for each value of time. The MATLAB commands can be given in two ways. Using the command window, you can write and execute each instruction one at a time. If you use script M-files, you can write entire program in MATLAB editor, save it and then execute the whole program whenever required.

Problems

1. Write the following program in MATLAB editor to generate and display a rectangular signal defined as,

$$rect\,(t) = \begin{cases} 1 & ;\ for\ |t| \le 1 \\ 0 & ;\ otherwise \end{cases}$$

```
%defining the time index of signal x(t)
t = -5:.01:5;

%defining the signal values for each value of time
x = zeros (size(t));
for i = 1:length(t)
      if abs(t(i)) <= 1
            x(i) = 1;
      else
            x(i) = 0;
      end
end

plot (t,x);
```

   Run the program and comment on the result.

2. Write a MATLAB program to display the signals $x_1(t) = 2\cos\left(\frac{\pi t}{3}\right)$, $x_2(t) = 3\cos\left(\frac{2\pi t}{9}\right)$ and $x_3(t) = x_1(t) + x_2(t)$. Observe the nature of each signal and identify their fundamental periods.

3. Write a MATLAB program to plot the real and imaginary parts of a periodic complex exponential signal $x(t) = e^{j\frac{4\pi}{3}t}$. Use suitable interval for defining the signal and observe the fundamental period of the signal. [Hint: use *real ( )* and *imag ( )* functions to extract real and imaginary parts of the signal.]

4. Write a MATLAB program to generate and display the discrete time unit step signal for appropriate time range. Use *stem( )* function to plot discrete time signals.

5. Write a MATLAB program to generate and plot the signals $x_1[n] = 5\cos\left(0.5n + \frac{\pi}{6}\right)$ and $x_2[n] = 5\cos\left(\frac{3\pi}{20}n + \frac{\pi}{3}\right)$. Comment on the nature and periodicity of the signals. Identify the fundamental period of the signals, if exists.

Section B

Transformation of Independent Variable

Following MATLAB functions are used to perform time shifting, time reversal and time scaling operations to a continuous time signal x(t). Write these functions in MATLAB editor and save them as M-files with filename same as the function name. The function can be called using the function name in the command window or in M-files.

In each of the following functions, *t* is the time support and *x* is the signal values for original signal. The increment used in *t* is represented by *del*.

```
% time shift x(t) -> x(t-to)
function [x1,t1]=tshift(x,t,to,del)
if to>0     %time delayed
      t1 = min(t) : del : max(t)+to;
      x1 = [zeros(1,length(t1)-length(t)) x];
else        %time advanced
      t1 = min(t)+to : del : max(t);
      x1 = [x zeros(1,length(t1)-length(t))];
end
plot(t1,x1);

% time scale x(t) -> x(alph*t)
function [x1,t1]=tscale(x,t,alph,del)
t1 = min(t)/alph : del/alph : max(t)/alph;
x1 = x;
plot(t1,x1);

% time reverse x(t) -> x(-t)
function [x1,t1]=treverse(x,t)
t1 = fliplr(-t);
x1 = fliplr(x);
plot(t1,x1);
```

Problems

1. Using the above functions, generate a single MATLAB function that performs combined transformation of time shifting, time reversal and time scaling i.e. $x(t) \rightarrow x(\alpha t + \beta)$.

2. Generate a continuous signal x(t) defined as,

$$x(t) = \begin{cases} t & ;for\ 0 \leq t \leq 2 \\ 1 & ;for 2 < t \leq 3 \\ 0 & ;otherwise \end{cases}$$

Use appropriate range and increment for time index and plot the signal.

3. For the signal x(t) defined in **Prob. 2**, generate and display the following signals using the function created in **Prob. 1**.

   a. $x(t + 2.5)$ b. $x(-0.75t + 7)$ c. $x(1.6t - 4.1)$