Lab 2-Fall 2016-2017
Visualizing and Manipulating Signals

Objective: to visualize & manipulate the continuous and discrete time-domain signals, and applying time-domain properties using MATLAB.

Pre-requests: Basics of MATLAB and fundamentals of signals & systems.
Useful References:

- Lecture Notes of the course,
- Signal processing & Linear Systems, (B. P. Lathi, ©2004, ISBN: 978-0-19-568583-1).
- Communication Systems, (Simon S. Haykin, © 2000, ISBN: 978-0-47-117869-9).

Procedure part I: For continuous-time signals; (45 minutes)

1. The unit step function $u(t)$

Unit step function or Heaviside function is defined as

$$u(t) = \begin{cases} 0 & t < 0 \\ \frac{1}{2} & t = 0 \\ 1 & t > 0 \end{cases}$$

In MATLAB, the unit step function is built-in function called heaviside(t). Follow the following steps to proof the above function and to draw it;

i. Type in MATLAB command window;

```
heaviside(-1)
heaviside(0)
heaviside(1)
```

ii. Draw the unit step function as follows;

```
t=-2:0.005:2;
plot(t,heaviside(t));
axis([-4 4 -0.5 1.5]);
```

iii. For simplicity, we can plot it using the command `ezplot('heaviside(t)', [-2 2]);`
iv. Shift t by 1 to the right and plot the result as follows;

```
t=-2:0.005:2;
plot(t,heaviside(t-1));
axis([-4 4 -0.5 1.5]);
```

v. Shift the signal to the left by 0.5 and plot the result.

2. The unit impulse function δ(t), it is defined as

$$\delta(t) = \begin{cases} \infty & t = 0 \\ 0 & t \neq 0 \end{cases}$$

Repeat sub steps **i, ii, iii, iv, v** of step 1 above using the built-in MATLAB unit impulse function, which is dirac(t).

3. The unit ramp function $r(t)$, it is defined as

$$r(t) = \begin{cases} t & t \leq 0 \\ 0 & t < 0 \end{cases}$$

Using MATLAB, the unit ramp function can be programmed as follows:

```
t=-10:0.005:10; % define time vector
sht=0;    % time shift value
ramp=(t+sht).*((t+sht)>=0); % define a ramp
plot(t,ramp) % plot ramp
```

- Repeat sub steps **i, ii, iii, iv, v** of step 1 above using the above program.

4. The ***sinc*** function, it is defined as;

$$\text{sinc}(t) = \frac{\sin \pi t}{\pi t}$$

```
t=-3:0.005:3;       % define the time vector
F=1;                % define the frequency
c=sinc(2*pi*F*t);   % write the sinc function
plot(t,c);          % sketch the signal
```

Try to change the frequency F and sketch the results.

<u>Procedure part II</u>: For Discrete-time signals; (45 minutes)

1. The unit step sequence $u[n]$, it is defined as

$$u[n] = \begin{cases} 1 & n \geq 0 \\ 0 & n < 0 \end{cases}$$

Use the following MATLAB program to repeat sub steps i-v of step 1 above;

```
n=-10:10; % specify index n
sht=0;    % define the shift value
u_step=((n+sht)>=0); % define the unit step sequence
stem(n, u_step) % plot the unit step sequence
```

2. The unit impulse sequence $\delta[n]$, it is defined as

$$\delta[n] = \begin{cases} 1 & n = 0 \\ 0 & n \neq 0 \end{cases}$$

Repeat sub steps of step 1 using the following program;

```
n=-10:10; % specify index n
sht=0;    % define the shift samples
delta=(n+sht == 0); % define the delta sequence
stem(n,delta) % plot the delta sequence
```

3. The unit ramp sequence $r[n]$, it is defined as

$$r[n] = \begin{cases} n, & n \geq 0 \\ 0, & n < 0 \end{cases}$$

Use the following program to repeat the sub steps of step 1;

```
n=-10:10; % specify index n
sht=0;    % define the shift samples
delta=(n+sht == 0); % define the delta sequence
stem(n,delta) % plot the delta sequence
```

4. The ***sinc*** sequence can be sketched as,

```
n=-10:10;      % define the time sequence
F=1;               % define the frequency
c=sinc(2*pi*F*n);  % write the sinc function
stem(n,c);         % sketch the signal
```

Discussion:

1. Answer the questions of the procedure and discuss the results of each step in procedure I and II
2. What was happen when you shift the signal in time-domain?
3. What was happen when you rotate the time of the signals? To simplify the question, what will be the result of the following MATLAB program and why?

```
n=-10:10;
sht=0;
u_step=((-n+sht)>=0);
stem(n, u_step)
```

4. What is the result of the following program?

```
t = 0:0.01:1;
y = [zeros(1,50),1,zeros(1,50)];
plot(t,y);
```

5. What is the result of the following program?

```
y = [zeros(1,50),ones(1,51)];
plot(t,y);
```

6. Give the result of the following MATLAB program and explain the function **rectpuls(t),**

```
t=-1:0.001:1;
y=rectpuls(t);
plot (t,y);
```

7. What will do the function tripuls(t), give the result for the following program,

```
t=-1:0.001:1;
y=tripuls(t);
plot (t,y);
```

8. What will be drawn after executing the following program?

```
fs = 10000;
t = 0:1/fs:1.5;
x = sawtooth(2*pi*50*t);
plot(t,x), axis([0 0.2 -1 1]);
```

9. Execute the following MATLAB program and plot the results in your report, also discuss the function square

```
t=0:20;
y=square(t);
plot(t,y)
```

<u>Next week</u>

Folding, Convolution, Correlation, Fourier series…

Good luck
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