

EE-322 Computer Experiment 1

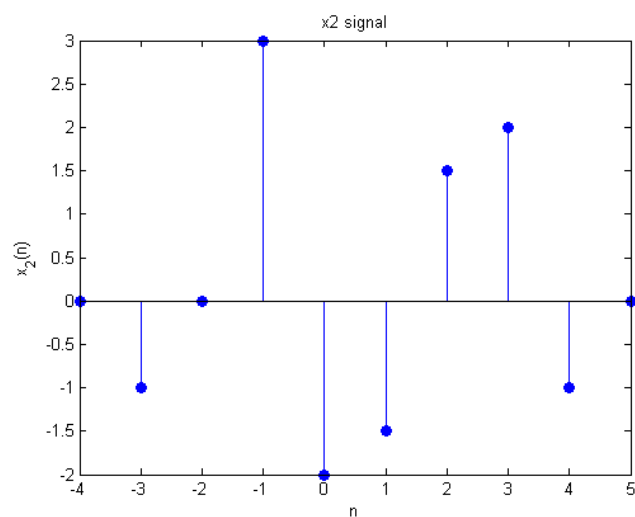
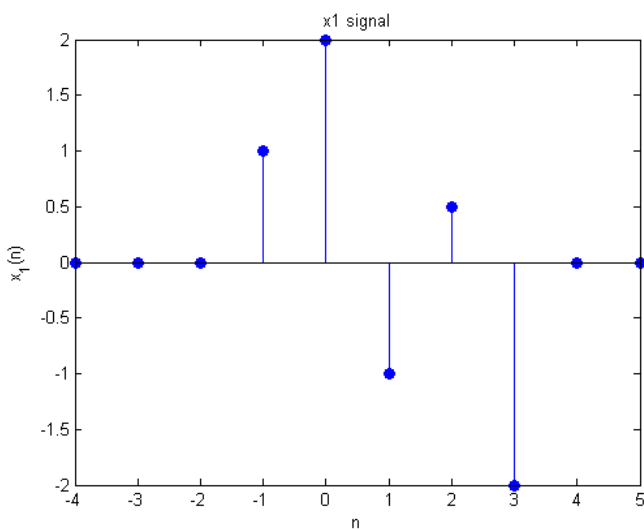
Discrete-time signals and sampling

Due : April-23, 2009

1. Simulate the signals shown below in Matlab. Then plot the following sequences using **sub-plots**: *Attach the plots with your answers.* Verify your answers with hand-calculations **(6 plots)**

- $x_1(n) + x_2(n)$
- $3x_1(n) - 2x_2(n)$
- $x_1(n)x_2(n)$
- $x_1(n-1)$
- $x_1(n-1) - x_2(n+1)$
- $x_1(n-1)x_2(n+1)$

Note: Use "help subplot" or "doc subplot" inside Matlab to learn more about using sub-plots to show all cases in the *same page*.



Example:

```
>> x1=[0 0 0 1 2 -1 0.5 -2 0 0]; % The extra zeros are needed to match the length of x2
>> n = -4:1:5; % the indices also match that of x2
>> stem(n,x1,'filled'); % the values show up in filled circles
>> ylabel('x_1(n)'); xlabel('n'); % Labels the y-axis and x-axis
>> title('x1 signal') % Puts the title at the top
```

Create the shifted the signals as follows:

```
>> x1_shift_right1(1:10) = 0;
>> x1_shift_right1(2:10) = x1(1:9);
>> x2_shift_left1(1:10) = 0;
>> x2_shift_left1(1:9) = x2(2:10);
```

2. Consider a periodic analog signal,

$$x(t) = 2 \sin\left(300\pi t + \frac{\pi}{4}\right)$$

- a) If the signal is sampled for a duration of 0.04 second, how many periods of the signal are sampled?
- b) If a sampling frequency $f_s = 1200\text{Hz}$ is selected, then how many samples will be collected during 0.04 second? Next, use MATLAB plot command to generate the sampled signal and plot the result. **(1 plot)**
- c) Generate 0.04 second (approximately) duration of the same signal using the sampling frequency of 300 Hz, 200 Hz, 150 Hz and 100 Hz, respectively, and plot the results. **(4 plots)**
- d) Write down a few sentences to describe your observations regarding these plots. *Attach the plots with your answers.*

3. Consider the following analog signal :

$$x(t) = \sin(150\pi t) + \frac{1}{3}\sin(450\pi t) + \frac{1}{5}\sin(750\pi t) + \frac{1}{7}\sin(1050\pi t) + \frac{1}{9}\sin(1350\pi t)$$

which represents a square-wave containing up to the 9th harmonic contents. The fundamental frequency is 150π radian/second.

- a) What should be the Nyquist Rate for sampling this signal?
- b) Sample the signal using a sampling frequency twice the Nyquist Rate. The sampling duration should cover 4 periods of the square-wave. Generate all of the harmonic contents and add them together to form the composite signal. Generate hard-copies of the plots for the waveforms with up to 5th, 7th and 9th harmonic contents **(3 plots)**, respectively. Observe the changes in the waveform on the screen as each harmonic content is being added into the signal.
- c) Change the sampling frequency to 750 Hz and sample 4 periods of the signal using this new sampling frequency. Generate hard-copies of the plots for the waveforms with up to 5th, 7th and 9th harmonic contents **(3 plots)**, respectively.
- d) Compare and contrast these six plots and discuss your observations and conclusions in a few sentences.