

ECEN 220 - Signals and Systems

Lab 1: Signals and LTI Systems

- 1) In class we discussed *periodicity* of signals, noting the differences in this property for continuous and discrete time signals. Let us investigate.

Consider a CT signal

$$x(t) = \sin 2\pi f_0 t$$

with $f_0 = 4$ Hz.

- Use MATLAB to plot $x(t)$ over a time interval of 1 second.
 - Now consider two sequences, $x_1[n]$ and $x_2[n]$ obtained by sampling $x(t)$ at sampling frequencies of $f_{s1} = 8f_0$ and $f_{s2} = 5f_0/2$, i.e. $x_1[n] = \sin(2\pi n/8)$ and $x_2[n] = \sin(4\pi n/5)$. Using the `stem` command, plot the sequences $x_1[n]$ and $x_2[n]$ for 32 and 10 samples, respectively. Do this on the same figure as $x(t)$. You will have to carefully scale the x -axis values to line-up the sequences. Make the plot nice and tidy, including a legend etc.
 - Compare the periodicity of the two sequences and how they relate to the period of $x(t)$. Verify your observations using the analysis we did in class.
- 2) Now let us investigate the *linearity* property of DT systems. Consider two systems, given by the following input/output relationships:

$$\text{System A: } y[n] = 2^{x[n]}$$

$$\text{System B: } y[n] = nx[n]$$

Using input signals $x_1[n] = 0.8^n$ and $x_2[n] = \cos[n]$, both for $0 \leq n \leq 5$, determine if Systems A and B are linear by examining their output sequences.

- 3) Finally, let's investigate DT convolution, using MATLAB's `conv` command.
- Consider a DT system with an impulse response $h[n] = 0.7^n$ for $0 \leq n \leq 10$. Plot (using `stem`) the output $y[n]$ to an input sequence $x[n] = u[n] - u[n - 4]$.
 - Verify your result by solving the convolution by hand and plotting your expression on the same graph. *Hint: Remember that $y[n] = x[n] * h[n] = h[n] * x[n]$. Choose the order wisely!*

This Lab is not assessed. However, what you have learnt here will be useful in the subsequent Labs.