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.
   a) Use MATLAB to plot $x(t)$ over a time interval of 1 second.
   b) 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.
   c) 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:
   $$\text{System A:} \quad y[n] = 2^{x[n]}$$
   $$\text{System B:} \quad y[n] = nx[n]$$
   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.
   a) 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 $x[n] = u[n] - u[n-4]$.
   b) 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!*

Hand in answers to questions, derivations and published Matlab code