# ECE431 Homework 1
# Signals and Systems Review

Due in 3pm Friday, September 7. Submit in WisCEL 410B to "MOBY 1".

**1.1.** OS Problem 2.30 a-c. Compute the convolutions using pencil (or pen) and paper. Then use `conv` in MATLAB to compute the convolutions and plot the results. Use the publish option in the file menu of MATLAB to display your MATLAB code and the results.

**1.2.** Consider an LTI system whose impulse response is $h[n] = (0.5)^n u[n]$.
(a) Determine the frequency response of the system. Sketch the magnitude of the frequency response. Is the system highpass, bandpass, or lowpass?
(b) Let $x[n] = \cos(\pi n) + 4\cos(\frac{\pi}{2}n)$ be the input to this system. Compute the output $y[n] = x[n] * h[n]$.
(c) Let $x[n] = \delta[n-1] + 3\delta[n-3]$ be the input to the system. Compute the output $y[n] = x[n] * h[n]$.

**1.3.** Download the MATLAB data file `mclips.mat` and the MATLAB program `music.m` from the web site. The program will playback either of the two music clips $x$ and $y$ contained in `mclips.mat`. The clip $y$ is a version of $x$ that has been digitally processed in MATLAB to produce an echo effect.
(a) Design and implement a linear system in MATLAB that processes the original clip $x$ to produce an echo with a 0.1 second delay (this should sound similar to $y$). Turn in the derivation of your echo system and the MATLAB code that implements it.
(b) Design and implement a nonlinear system in MATLAB that produces a saturation effect. That is, mimic the effect of pushing an amplifier into saturation by clipping $x$ whenever the magnitude of its amplitude is greater than a certain level (e.g., $|x[n]| > 0.7$). Turn in your design and the MATLAB code that implements it.

**1.4.** Verify the inverse DTFT formula

$$h[n] = \frac{1}{2\pi}\int_{-\pi}^{\pi} H(\omega)e^{j\omega n}d\omega$$

by replacing $H(\omega)$ with the DTFT expression

$$H(\omega) = \sum_{k=-\infty}^{\infty} h[k]e^{-j\omega k}$$

and show that you obtain $h[n]$ on both sides of the equation.