

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Department of Electrical and Computer Engineering
ECE 498MH SIGNAL AND IMAGE ANALYSIS

Homework 6
Fall 2014

Assigned: Thursday, 2/23/2017

Due: Thursday, 3/2/2017

Reading: 1–40

Do **one** of the following two problems, and submit by 11:59pm 3/2/2017 (on Compass, if you don't hand it in during class). Homework will be handed back on 3/7/2017. If you don't like your grade, then you can hand in the **other** problem for a grade, no later than 3/14/2017.

Problem 6.1

AM radio creates a radio-frequency signal, $y[n]$, by multiplying the audio-frequency signal, $x[n]$, times a radio-frequency carrier signal $\cos(\alpha n)$ where α is some appropriately high frequency:

$$y[n] = \cos(\alpha n)x[2n]$$

- (a) Is this system linear? Prove your answer, by determining whether or not $x_3[n] = ax_1[n] + bx_2[n]$ produces the output $y_3[n] = ay_1[n] + by_2[n]$.
- (b) Is this system time-invariant? Prove your answer, by determining whether or not $x_2[n] = x_1[n - n_0]$ produces the output $y_2[n] = y_1[n - n_0]$.

Problem 6.2

One of the ways in which an image differs from other signals is that the pixels of an image are all non-negative, $0 \leq y[n] \leq 255$, where $y[n] = 0$ means black, and $y[n] = 255$ means white. Suppose that you have a zero-average signal, $-127 \leq x[n] \leq 127$. You can create an image from $x[n]$ by adding a constant:

$$y[n] = x[n] + 127$$

- (a) Is this system linear? Prove your answer, by determining whether or not $x_3[n] = ax_1[n] + bx_2[n]$ produces the output $y_3[n] = ay_1[n] + by_2[n]$.
- (b) Is this system time-invariant? Prove your answer, by determining whether or not $x_2[n] = x_1[n - n_0]$ produces the output $y_2[n] = y_1[n - n_0]$.