

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

Homework 3
Fall 2013

Assigned: Friday, September 20, 2013

Due: Friday, September 27, 2013

Reading: Signal Processing First (SPF) Chapter 5

Problem 3.1

- (a) $y[n] = x[n] - x[0]$ is linear.
- (b) $y[n] = x[n] - 1$ is nonlinear (a system like this, nonlinear only because of the constant offset, is called “affine”). For example,

$$\begin{aligned}x_1[n] = \cos \pi n &\Rightarrow y_1[n] = \begin{cases} 0 & n \text{ even} \\ -2 & n \text{ odd} \end{cases} \\x_2[n] = 1 &\Rightarrow y_2[n] = 0 \\x_3[n] = x_1[n] + x_2[n] &\Rightarrow y_3[n] = \cos \pi n \neq y_1[n] + y_2[n]\end{aligned}$$

Problem 3.2

- (a) $y[n] = x[n] - x[0]$ is time-varying. For example,

$$\begin{aligned}x_1[n] = \cos \pi n &\Rightarrow y_1[n] = \begin{cases} 0 & n \text{ even} \\ -2 & n \text{ odd} \end{cases} \\x_2[n] = x_1[n-1] &\Rightarrow y_2[n] = \begin{cases} 0 & n \text{ even} \\ 2 & n \text{ odd} \end{cases} \neq y_1[n-1]\end{aligned}$$

- (b) $y[n] = x[n] - 1$ is time-invariant.

Problem 3.3

$$y[n] = \begin{cases} 0 & n \leq -2, n \geq 4 \\ 0.5 & n = -1, 3 \\ 1.5 & n = 0, 2 \\ 2 & n = 1 \end{cases}$$

Problem 3.4

