

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

**Homework 4**  
Fall 2014

Assigned: Thursday, 2/9/2017

Due: Thursday, 2/16/2017

Reading: 1–40

Do **one** of the following two problems, and submit by 11:59pm 2/16/2017 (on Compass, if you don't hand it in during class). Homework will be handed back on 2/21/2017. If you don't like your grade, then you can hand in the **other** problem for a grade, no later than 2/28/2017.

**Problem 4.1**

A cosine with a period of  $M_0 = 5$  samples is upsampled by a factor of  $M = 2$ . The resulting signal has a period of  $N_0 = MM_0 = 10$  samples, therefore it can be expressed as a Fourier series:

$$x[m] = \cos\left(\frac{2\pi m}{5}\right), \quad y[n] = \begin{cases} x[m] & n = 2m \\ 0 & \text{otherwise} \end{cases}$$

$$y[n] = \sum_{k=0}^9 Y_k e^{jk\omega_0 n}$$

where  $\omega_0 = \frac{2\pi}{10}$ . Find all 10 of the coefficients  $Y_k$ , for  $0 \leq k \leq 9$ .

**Problem 4.2**

A sine with a period of  $M_0 = 4$  samples is upsampled by a factor of  $M = 2$ . The resulting signal has a period of  $N_0 = MM_0 = 8$  samples, therefore it can be expressed as a Fourier series:

$$x[m] = \sin\left(\frac{2\pi m}{4}\right), \quad y[n] = \begin{cases} x[m] & n = 2m \\ 0 & \text{otherwise} \end{cases}$$

$$y[n] = \sum_{k=0}^7 Y_k e^{jk\omega_0 n}$$

where  $\omega_0 = \frac{2\pi}{8}$ . Find all 8 of the coefficients  $Y_k$ , for  $0 \leq k \leq 7$ .