

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

**Homework 4**  
Fall 2013

Assigned: Friday, September 27, 2013

Due: Friday, October 11, 2013

Reading: Signal Processing First (SPF) Chapter 6

**Problem 4.1**

$$h[n] = 0.5\delta[n] + 0.6\delta[n - 1] + \delta[n - 2]$$

**Problem 4.2**

(a)

$$\begin{aligned}H(\omega) &= 1 - e^{-j\omega} \\M(\omega) &= \sqrt{(1 - \cos \omega)^2 + \sin^2(\omega)} = \sqrt{2 - 2 \cos \omega} = 2 \sin(\omega/2) \\ \theta(\omega) &= \text{atan2}(1 - \cos \omega, \sin \omega) = -\frac{\omega}{2} \pm \pi \\y[n] &= M(\omega) \cos(\omega n + \theta(\omega))\end{aligned}$$

(b)

$$\begin{aligned}H(\omega) &= 1 + 0.6e^{-3j\omega} + 0.4e^{-4j\omega} \\M(\omega) &= \sqrt{(1 + 0.6 \cos 3\omega + 0.4 \cos 4\omega)^2 + (-0.6 \sin 3\omega - 0.4 \sin 4\omega)^2} \\ \theta(\omega) &= \text{atan2}(1 + 0.6 \cos 3\omega + 0.4 \cos 4\omega, -0.6 \sin 3\omega - 0.4 \sin 4\omega) \\y[n] &= M(\omega) \cos(\omega n + \theta(\omega))\end{aligned}$$

(c)

$$\begin{aligned}H(\omega) &= 0.5 + 0.6e^{-j\omega} + e^{-2j\omega} \\M(\omega) &= \sqrt{(0.5 + 0.6 \cos \omega + \cos 2\omega)^2 + (-0.6 \sin \omega - \sin 2\omega)^2} \\ \theta(\omega) &= \text{atan2}(0.5 + 0.6 \cos \omega + \cos 2\omega, -0.6 \sin \omega - \sin 2\omega) \\y[n] &= M(\omega) \cos(\omega n + \theta(\omega))\end{aligned}$$

**Problem 4.3**

$$y[n] = \begin{cases} 0 & n \leq -1, \quad n \geq 11 \\ 1 & n = 0, \quad n = 10 \\ 2 & n = 1, \quad n = 9 \\ 3 & n = 2, \quad n = 8 \\ 4 & 3 \leq n \leq 7 \end{cases}$$

