UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Department of Electrical and Computer Engineering

ECE 498MH Signal and Image Analysis

Homework 5

Fall 2013

Assigned: Friday, October 11, 2013 Due: Friday, October 18, 2013

Reading: SPF Chapter 7 and Sections 8.1-8.5

Problem 5.1

(a) Recursive formula generates an infinite-length $h[n]$, so it's an IIR filter.

(b) $h[-1] = 0, h[0] = 1, h[1] = 1, h[2] = 0.5, h[3] = 0$

(c) $H(z) = \frac{1+0.5z^{-1}+0.25z^{-2}}{1-0.5z^{-1}+0.25z^{-2}}$

(d)

$$\text{Poles: } p_{1,2} = \frac{1}{2} \pm j\frac{\sqrt{3}}{4}, \quad \text{Zeros: } r_{1,2} = -\frac{1}{2} \pm j\frac{\sqrt{3}}{4}$$

(e) $H_d(\omega) = \frac{1+0.5e^{-j\omega}+0.25e^{-2j\omega}}{1-0.5e^{-j\omega}+0.25e^{-2j\omega}}$

ω	$H_d(\omega)$	$\lvert H_d(\omega)\rvert$
0	$\frac{5}{3}$	$\frac{5}{3}$
$\frac{\pi}{2}$	$\frac{0.75-0.5j}{0.75+0.5j}$	1
π	$\frac{3}{5}$	$\frac{3}{5}$

(f)

(g) Lowpass

Problem 5.2

Consider the FIR filter $h[n] = 0.25\delta[n+2] + 0.5\delta[n+1] + \sqrt{3}\delta[n] + 0.5\delta[n-1] + 0.25\delta[n-2]$.

(a) $H_d(\omega) = \sqrt{3}\cos(0) + \cos(\omega) + 0.5\cos(2\omega)$

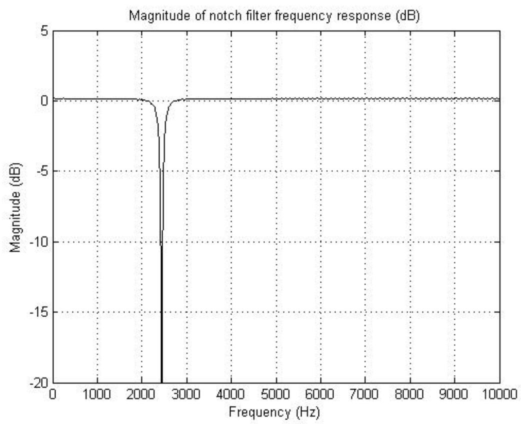
ω	$H_d(\omega)$	$\lvert H_d(\omega)\rvert$	$\angle H_d(\omega)$
0	$\sqrt{3}+\frac{3}{2}$	$\sqrt{3}+\frac{3}{2}$	0
$\frac{\pi}{4}$	$\sqrt{3}+\frac{\sqrt{2}}{2}$	$\sqrt{3}+\frac{\sqrt{2}}{2}$	0
$\frac{\pi}{2}$	$\sqrt{3}-\frac{1}{2}$	$\sqrt{3}-\frac{1}{2}$	0
$\frac{3\pi}{4}$	$\sqrt{3}-\frac{\sqrt{2}}{2}$	$\sqrt{3}-\frac{\sqrt{2}}{2}$	0
π	$\sqrt{3}-0.5$	$\sqrt{3}-0.5$	0

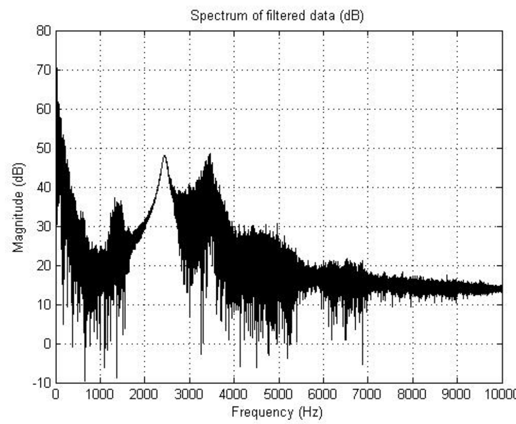
(b)

(c) You could call it lowpass or bandstop.

Matlab Exercises

Problem 5.3





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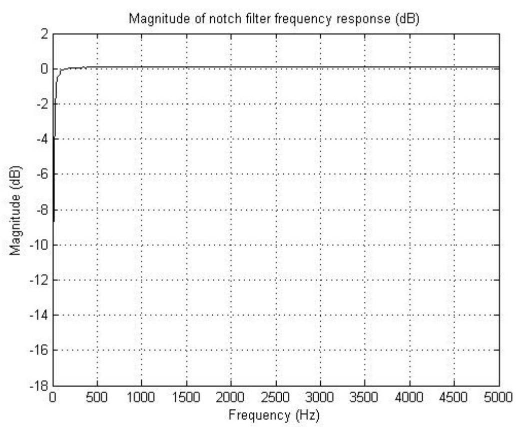
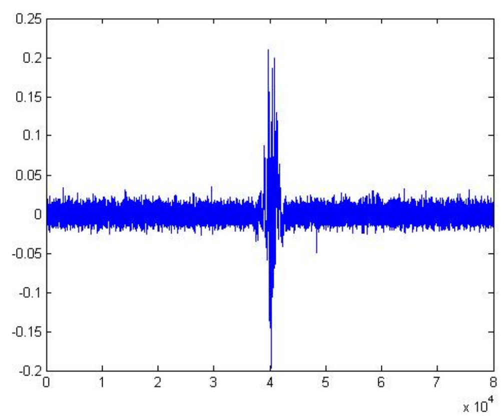
Problem 5.4





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