ESE 531 Recitation 9

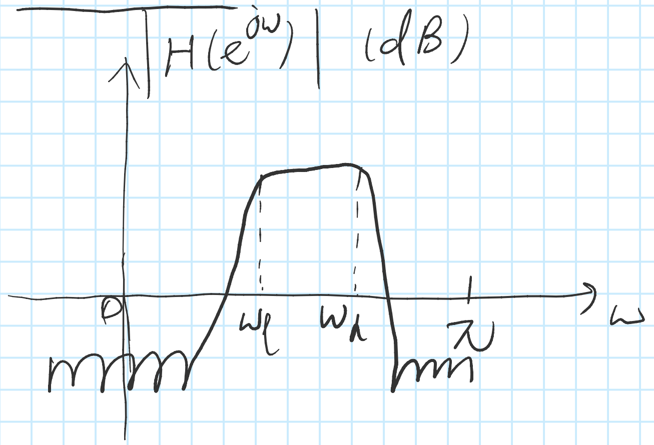
Project 1, Part B

(a).

What is an octave filter?

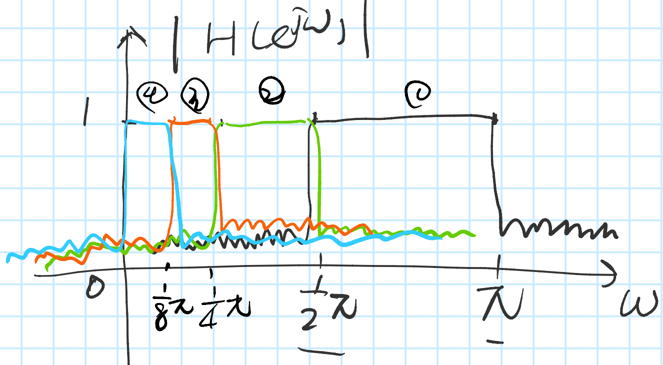
$\omega_h \Rightarrow$ highest frequency
$\omega_\ell \Rightarrow$ lowest freq. } for a filter

Octave: $\omega_h = 2 \times \omega_\ell$



$\Rightarrow \omega_h = 2\,\omega_\ell$

A four-channel Octave band:



$\Rightarrow$ 4 channels
each channel has an octave filter

$\Rightarrow$ Need to design a filter bank in the figure above.

$\Rightarrow$ How to design filter 1?

use firpr2chfb $\Rightarrow$ $N = 99$, $f_p = 0.45$

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$\Rightarrow$ h_1 in $[h_0, h_1, g_0, g_1]$ (which is the result returned from firpr2chfb) is the filter ① in the 4-channel FB.

$\Rightarrow$ Think about ways to design filter ②, ③, ④

(b). Say $x_t[n] = \sum_{i=1}^{4} x_i[n]$

x_i is a sinusoidal function (sequence) with frequency that lies in each of the 4 pass-bands.

$\Rightarrow$ input x_t to 4-channel FB

Should expect at the output:

get y_1 from channel 1

---- y_2 ------ 2 in which $y_i = x_i$

---- y_3 ------ 3

---- y_4 ------ 4

Also, if you add up y_i, $y_t = \sum_{i=1}^{4} y_i = x_t$

Problem 5.24 from Textbook in HW6

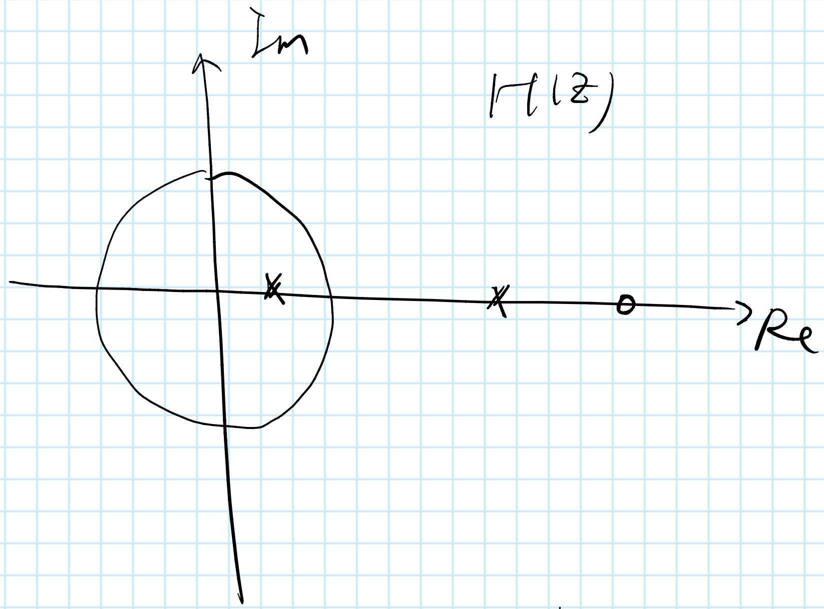
Recall a property of the transfer function $H(z)$ in the following form:

$\prod^{M} (1 - b_i z^{-1})$, M is

$$H(z) = \frac{\prod_{i=1}^{M} (1 - b_i z^{-1})}{\prod_{j=1}^{N} (1 - a_j z^{-1})}$$ (M is not necessarily equal to N)

Then we have

$$\boxed{\# \text{ of poles} = \# \text{ of zeroes}}$$



$$H(z) = \frac{1 - 4z^{-1}}{(1 - \frac{1}{2} z^{-1})(1 - 3z^{-1})}$$

$$H(z) = H_{min}(z) \, H_{ap}(z)$$

Recall : for a min-phase sys. all of its zeroes & poles are inside u.c.

for a all-pass system, $|H_{allpass}(e^{j\omega})| = 1$ for ω.

⇒ Need to flip a zero that's outside u.c.

⇒ $(1-4z^{-1})$ goes to numerator of $H_{min}(z)$.

$$\Rightarrow \quad H_{min}(z) = \frac{(1-4z^{-1})^{x}}{(1-\frac{1}{2}z^{-1})(1-\frac{1}{3}z^{-1})}$$

additional zero at 0

$$H_{ap}(z) = \frac{(1-4z^{-1})(1-\frac{1}{3}z^{-1}) \times z^{-1}}{(1-3z^{-1})(1-4z^{-1})}$$