Given:

\[ H^c(s) \text{ be a cheb-I LPF}, \]
\[ N=3, \quad \omega_p=3, \quad \omega_s=10, \quad \delta_s=0.02 \quad \text{"Exactly"} \]

Ask: \( H^c(s) \)?

Cheb-I:

\[
\left| H(w) \right|^2 = \frac{1}{1 + \delta^2 T_N \left( \frac{w}{\omega_0} \right)}.
\]

\( s=jw \)

\[
\left| H(s) \right|^2 = H^c(s) H^c(-s) = \frac{1}{1 + \delta^2 T_N \left( \frac{w}{j\omega} \right)}
\]

Analysis Poles:

Butterworth

Cheb-I

\( s=0+j\omega \)

\( e^{z^2} \text{ stable} \)
$H^*(s) = H_0 \left[ \frac{S_k}{s-S_k} \right]$  

General:

$$W_p, W_s, \omega_p, \omega_s$$

$\Rightarrow d, k, \epsilon, N, w_0$  

$\Rightarrow S_k$.

How to solve such kind problem?

- Known $\Rightarrow \cdots \Rightarrow \cdots \Rightarrow$ unknown
- $\Rightarrow \cdots \Rightarrow \cdots \Rightarrow$
Given: music sampling freq 48 kHz.
filter: \( w_p, w_s, s_p, s_s \).
passband, ~ monotone

Ask: what kind of IIR filter?
what are they?

Bessel
\[ N, w_o \]

Cheb - 1
\[ N, w_o \]

Cheb - II
\[ N, w_o, 3 \]
11.4 The filter:

\[ H(z) = 1 + z^{-1} + \cdots + z^{-(n-1)} \]

Direct implement. \((n-1)\) Add, \(0\) Mul.

Ack. other? \(2\) Add, \(0\) Mul.

\[ H(z) = \frac{1 - z^{-n}}{1 - z^{-1}} \]

\[ y(z) = H(z) x(z) \]

\[ = \frac{1 - z^{-n}}{1 - z^{-1}} x(z) \]

\[ (1 - z^{-1}) y(z) = (1 - z^{-n}) x(z) \]

\[ x(n) - y(n-1) = x(n) - x(n-N) \]

\[ y(n) = y(n-1) + x(n) - x(n-N) \]

\[ x(k) \rightarrow \oplus \rightarrow y(n) \]
help files of "filter" of Matlab.

Rational $H(z)$ ~ implementing ✓

\[ x[n] = \Phi s[n] \]

\[ \begin{array}{c}
\uparrow \\
2 \\
\downarrow \\
\circ \quad -1 \quad 2 \\
\downarrow \\
\circ \quad \Theta \quad + \quad 1 \\
\downarrow \\
2 \\
\end{array} \]

\[ y[n] = \left[ -\cos\Theta \cdot s[n] + 2\cos\Theta \cdot s[n] \Phi - s[n-1] \right] \]

\[ \begin{array}{c}
S[n] = \\
\text{delay 1 unit} \\
\text{initial cond.} \\
\text{omit } S[n] \quad , \quad Y[n] = \ldots \quad y[n-1] \quad \ldots \quad y[n-2] \\
\downarrow 2 \\
\end{array} \]