

Contoh perancangan IIR dengan tipe Chebyshev I

Direncanakan desain filter yang meloloskan sinyal di bawah 300Hz dengan redaman 3dB. Redaman 20dB pada frekuensi 400Hz. Pada bagian passband terdapat ripple. Frekuensi sampling 1200Hz.

Hitung: a. Orde filter

b. Respon LPF ternormalisasi $H_n(s)$

c. Respon filter digital $H(z)$

$$W_p = \frac{2n \cdot fp}{F_s} = \frac{2n \cdot 300}{1200} = \frac{n}{2} \text{ rad/sample}$$

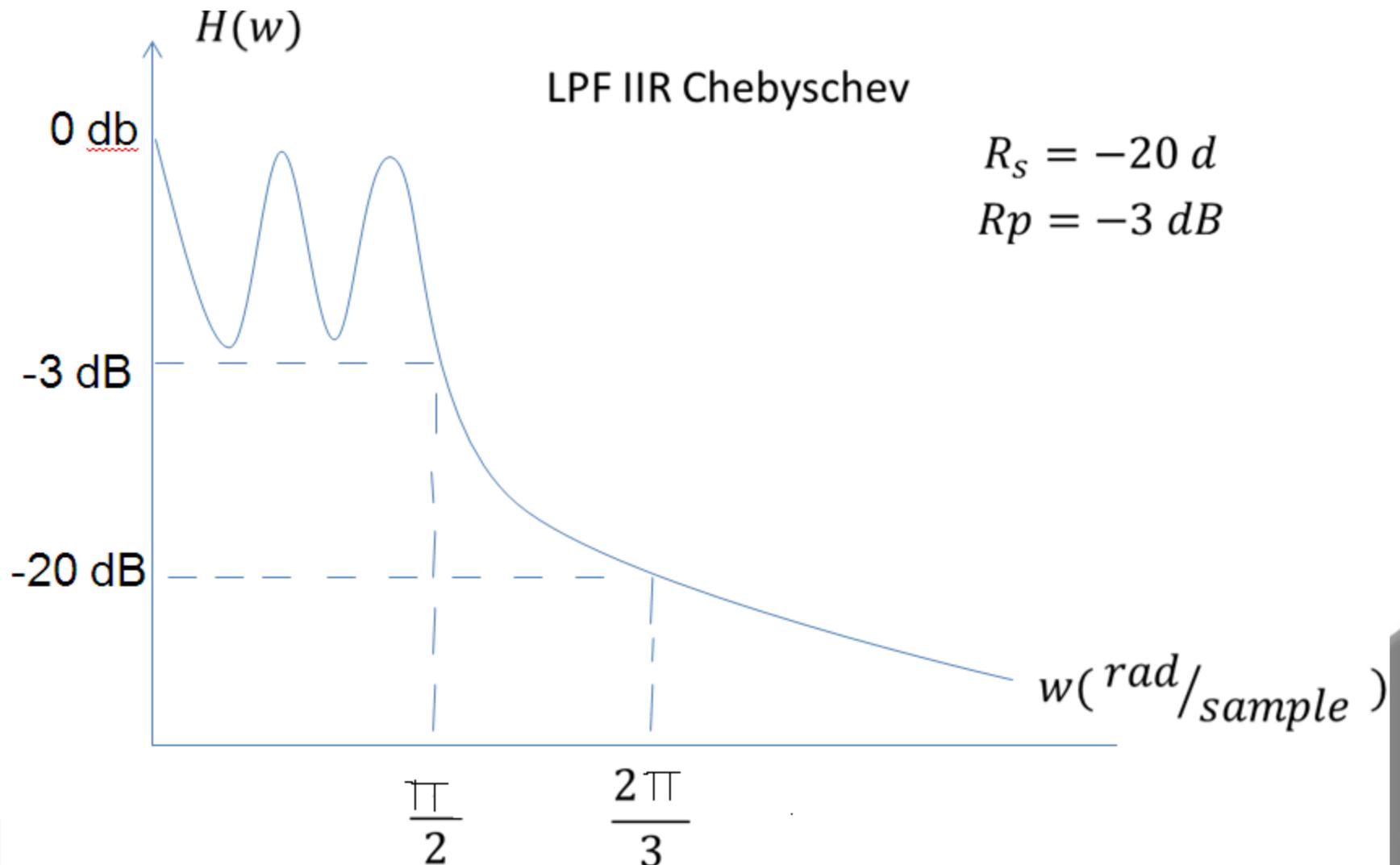
$$W_s = \frac{2n \cdot fs}{F_s} = \frac{2n \cdot 400}{1200} = \frac{2}{3} \pi \text{ rad/sample}$$

$$\Omega_p = 2F_s \cdot \tan\left(\frac{W_p}{2}\right) = 2 \cdot 1200 \cdot \tan\left(\frac{1}{2} \cdot \frac{n}{2}\right) = 2400 \text{ rad/detik}$$

$$\Omega_s = 2F_s \cdot \tan\left(\frac{W_s}{2}\right) = 2 \cdot 1200 \cdot \tan\left(\frac{1}{2} \cdot \frac{2}{3} n\right) = 4152 \text{ rad/detik}$$

Backward LPF :

$$\Omega_c = \frac{\Omega_s}{\Omega_p} = \frac{4152}{2400} = 1,73$$



a) orde filter :

$$n = \left\lceil \frac{\log(9 + \sqrt{9^2 - 1})}{\log(\Omega_c + \sqrt{\Omega_c^2 - 1})} \right\rceil$$

$$a^2 = 10^{\frac{-R_s}{10}} = 10^{\left(-\frac{-20}{10}\right)} = 100$$

$$\varepsilon^2 = 10^{\frac{-R_p}{10}} - 1 = 10^{\left(-\frac{-3}{10}\right)} - 1 = 1.995 - 1 = 0.995$$

$$9 = \sqrt{\frac{a^2 - 1}{\varepsilon^2}}$$

$$= \sqrt{\frac{100 - 1}{0.995}}$$

$$= 9.975$$

$$n = \left\lceil \frac{\log(9,975 + \sqrt{9,975^2 - 1})}{\log(1,73 + \sqrt{1,73^2 - 1})} \right\rceil$$

$$= \left\lceil \frac{1,29885}{0,497} \right\rceil$$

$$= \lceil 2,61 \rceil$$

$$= 3$$

Untuk n ganjil maka :

$$H_n = \frac{b_0}{s^3 + b_2 \cdot s^2 + b_1 \cdot s + b_0}$$

b) . Lihat tabel chebyshev pada ripple 3 dB maka

$$H_n(s) = \frac{0.25059}{s^3 + 0.59724 s^2 + 0.92835s + 0.25059}$$

C). Proses forward

$$H(s) = \left. H_n(s) \right|_{s \rightarrow \frac{s}{\Omega p}}$$

$$= \frac{0.25059}{\left(\frac{s}{2400}\right)^3 + 0.59724 \left(\frac{s}{2400}\right)^2 + 0.92835 \left(\frac{s}{2400}\right) + 0.25059}$$

Tranformasi bilinier :

$$H(z) = H(s) \Big|_{s=2Fs \cdot \frac{z-1}{z+1}}$$

End