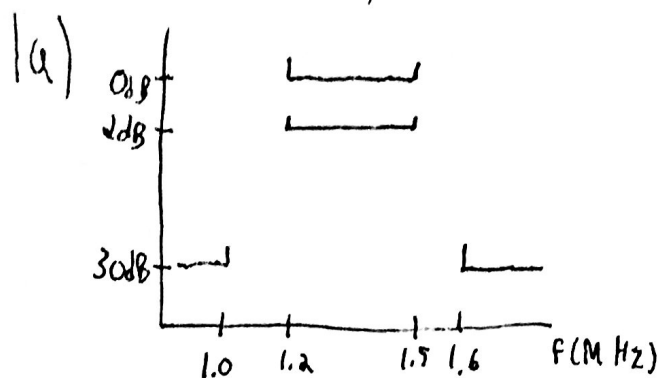


DSP HW 3

Ivan Chowdhury



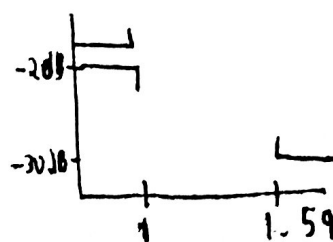
$$\begin{aligned}
 B &= \omega_{Hi} - \omega_{Lo} = 1.5 \text{ MHz} - 1.2 \text{ MHz} = 0.3 \text{ MHz} \\
 &= 300 \text{ kHz} \\
 &= 6\pi \cdot 10^5 \frac{\text{rad}}{\text{s}}
 \end{aligned}$$

$$\begin{aligned}
 \omega_0 &= \sqrt{\omega_{Hi} \cdot \omega_{Lo}} = \sqrt{(1.5)(1.2)} = \sqrt{1.8} = 1.34 \text{ MHz} \\
 &= 2.68\pi \cdot 10^6 \frac{\text{rad}}{\text{s}}
 \end{aligned}$$

$$1) \omega_p = \left| \frac{\omega_{BP}^2 - \omega_0^2}{B \cdot \omega_{BP}} \right| = \left| \frac{(1.6 \text{ MHz})^2 - (1.34 \text{ MHz})^2}{(0.3 \text{ MHz})(1.6 \text{ MHz})} \right| = 1.59 \text{ MHz}$$

$$2) \omega_p = \left| \frac{1^2 - 1.34^2}{(0.3)(1)} \right| = 2.65$$

Use the lower frequency



1b) Butterworth

$$\begin{aligned}
 h &\geq \frac{.5 \log_{10} (\delta(r_s) / \delta(r_p))}{\log_{10} (\omega_s / \omega_p)} \quad \begin{matrix} r_p = 20 \text{ dB} \\ r_s = 30 \text{ dB} \\ \omega_p = 1.59 \\ \omega_s = 1 \end{matrix} \\
 &\geq \frac{.5 \log_{10} ((10^{30/10} - 1) / (10^{20/10} - 1))}{\log_{10} (1 / 1.59)}
 \end{aligned}$$

$$\geq 6.87$$

$$h = 7$$

1c) Chebyshev

$$n \geq \frac{\cosh^{-1} \left(\sqrt{\delta(r_s)/\delta(r_p)} \right)}{\cosh^{-1}(w_s/w_p)}$$

$$\begin{aligned} r_s &= 30 \\ r_p &= 1 \\ w_s &= 1 \\ w_p &= 1.59 \end{aligned}$$

$$n \geq \frac{\cosh^{-1} \left(\sqrt{(10^{30/10} - 1) / (10^{2/10} - 1)} \right)}{\cosh^{-1}(1/1.59)}$$

$$n \geq 4.9567$$

$$n = 5$$

Butterworth = 14

Chebyshev = 10