

(3)

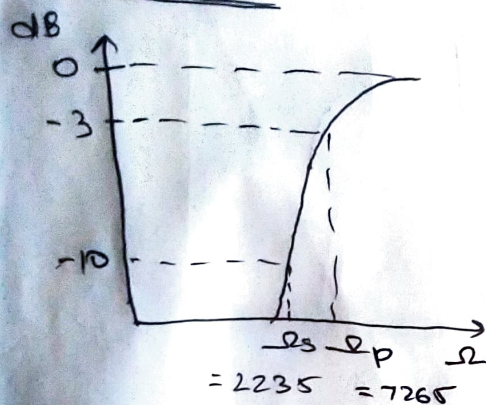
Given $\alpha_p = 3 \text{ dB}$ cut off frequency $= 1000 \text{ Hz}$ sampling frequency $= 5000 \text{ Hz}$

$$\omega_c = \omega_p = 2\pi \times 1000 = 2000\pi \text{ rad/sec.}$$

$$\alpha_s = 10 \text{ dB}$$

$$\omega_s = 2\pi \times 350 = 750\pi \text{ rad/sec.}$$

$$T = 1/f = \frac{1}{5000} = 2 \times 10^{-4} \text{ sec}$$

High passmonotonic \Rightarrow Butterworth filter

$$\Omega_p = \frac{2}{T} \tan \frac{\omega_p T}{2}$$

$$= \frac{2}{2 \times 10^{-4}} \tan \left(\frac{2000\pi \times 2 \times 10^{-4}}{2} \right)$$

$$= 10^4 \tan(0.2\pi) = 7265 \text{ rad/sec}$$

$$\boxed{\Omega_p = 7265 \text{ rad/sec}}$$

$$\Omega_s = \frac{2}{T} \tan \frac{\omega_s T}{2} = \frac{2}{2 \times 10^{-4}} \tan \left(\frac{750\pi \times 2 \times 10^{-4}}{2} \right)$$

$$\boxed{\Omega_s = 10^4 \tan(0.07\pi) = 2235 \text{ rad/sec}}$$

Order of filter

$$N = \frac{\log \frac{10^{0.1\alpha_s} - 1}{10^{0.1\alpha_p} - 1}}{\frac{\log \Omega_s}{\log \Omega_p}} = \frac{\log \frac{10^{0.1(10)} - 1}{10^{0.1(3)} - 1}}{\frac{\log 2235}{\log 7265}} = \frac{\log 3}{\log 3.25}$$

$$= \frac{0.4771}{0.5118} = 0.932$$

$$\therefore N = 0.932 \approx 1$$

First order Butterworth filter for $\Omega_c = 1 \text{ rad/sec}$

$$\text{is } H(s) = \frac{1}{1+s}$$

High pass filter for $\Omega_c = \Omega_p = 7265 \text{ rad/sec}$
can be obtained by $s = \frac{\Omega_c}{s}$

Transfer function for High Pass Filter

$$H(s) = \frac{1}{s+1} \quad \left| s = \frac{7265}{s} \right.$$

$$= \frac{s}{s+7265}$$

using bilinear transformation.

$$H(z) = H(s) \quad \left| s = \frac{2}{T} \left[\frac{1-z^{-1}}{1+z^{-1}} \right] \right.$$

$$= \frac{s}{s+7265} \quad \left| s = \frac{2}{2 \times 10^{-4}} \left[\frac{1-z^{-1}}{1+z^{-1}} \right] \right.$$

$$= \frac{1000 \left[\frac{1-z^{-1}}{1+z^{-1}} \right]}{1000 \left[\frac{1-z^{-1}}{1+z^{-1}} \right] + 7265}$$

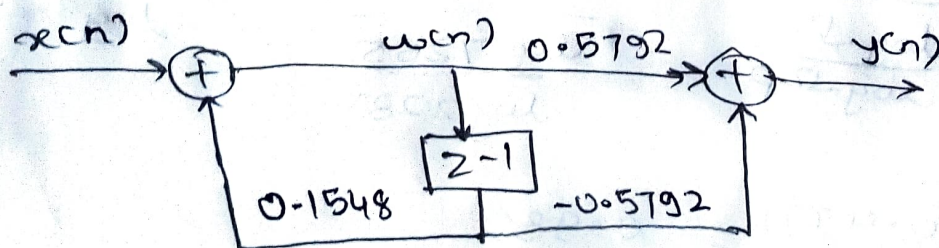
$$= \frac{0.5792 (1-z^{-1})}{1 - 0.1548 z^{-1}}$$

$$H(z) = \frac{0.5792 - 0.5792 z^{-1}}{1 - 0.1548 z^{-1}}$$

$$H(z) = H_1(z) H_2(z) = \frac{1}{1 - 0.1548 z^{-1}} (0.5792 - 0.5792 z^{-1})$$

$$H_1(z) = \frac{1}{1 - 0.1548 z^{-1}}$$

$$H_2(z) = 0.5792 - 0.5792 z^{-1}$$



Direct form-II. realization.