~~F/s = 800~~

ws =

* Butterworth digital filter:

→ Sampling freq^n = 5000 Hz

Cut-off frequency = 1000 Hz

and down 10 dB at 350 Hz.

$\alpha_p = 3$ dB $\qquad F_p = 1000$ Hz

$\alpha_s = 10$ dB $\qquad \omega_p = 2\pi \times 1000$

$= 2000\pi$ rad/sec

$\omega_s = 2\pi \times 350 = 700\pi$ rad/s.

$$T = \frac{1}{f_s} = \frac{1}{5000} = 2 \times 10^{-4} \text{ seconds.}$$

→ pre-warping

$$\Omega_p = \frac{2}{T} \tan\left(\frac{\omega_p T}{2}\right)$$

$$= \frac{2}{2\times10^{-4}} \tan\left(\frac{2000 \times 2\times10^{-4}}{2}\right)$$

$= 7265$ rad/sec

$\Omega_s = 2235$ rad/sec.

Reverse it since HPF

$\Omega_p = 2235$, $\Omega_s = 7265$

LPF - Butterworth filter

1) Order :-

$$N \geq \log \sqrt{\frac{10^{0.1\alpha_s} - 1}{10^{0.1\alpha_p} - 1}} \geq 0.932$$

$$\log\left(\frac{\Omega_s}{\Omega_p}\right) = 1$$

$N = 1$

$H(s) = \frac{1}{s+1}$, $\Omega_c = 1$

$\Omega_c = \Omega_p = 7265$ rad/sec.

$s \rightarrow \frac{7265}{}$

$$H(s) = \frac{1}{\frac{7265}{s} + 1}$$

rad/sec = 0.5

$$H_a(s) = \frac{s}{s + 7265}$$

1 rad = 0.15924

5000 Hz

$$\frac{5000}{0.1592}$$

$$s = \frac{2}{T}\left(\frac{1 - z^{-1}}{1 + z^{-1}}\right)$$

$$H(z) = \frac{0.5792\,(1 - z^{-1})}{(1 - 0.1584\,z^{-1})}$$

$$Y(z) = H(z)\,X(s).$$

$$H(z) = \frac{0.5792\left(z - \frac{1}{z}\right)}{z - 0.1584\,\frac{1}{z}}$$

$$H(z) = \frac{0.5792\,(z - 1)}{z - 0.1584}$$

$$Y(z) = H(z)\, X(z)$$

$$Y(z) = \left(\frac{0.5792\,(1 - z^{-1})}{1 - 0.1584\, z^{-1}} \right) X(z)$$

$$Y(z) - 0.15784\, Y(z)\, z^{-1} = 0.5792\, X(z) - 0.5792\, z^{-1} X(z)$$

$$y(n) - 0.15784\, y(n-1) = 0.5792\, x(n) - 0.5792\, x(n-1)$$

$$y(n) = 0.5792\, x(n) - 0.5792\, x(n-1) + 0.15784\, y(n-1)$$