Problem -3

Let $\alpha_p = 3dB$

$w_c = w_p = 2\times\pi\times1000 = 2000\pi$ rad/sec

$\alpha_s = 10dB$

$w_s = 2\times\pi\times350 = 700\pi$ rad/sec

$T = \frac{1}{f} = \frac{1}{5000} = 2\times10^{-4}$ sec

W.K.t $\Omega_p = \frac{2}{T}\tan\frac{w_pT}{2}$

$= \frac{2}{2\times10^{-4}}\tan\frac{(2000\pi\times2\times10^{-4})}{2}$

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

$\Omega_s = \frac{2}{T}\tan\frac{w_sT}{2}$

$= \frac{2}{2\times10^{-4}}\tan\frac{(700\pi\times2\times10^{-4})}{2}$

$= 10^4\tan(0.07\pi) = 2235$ rad/sec

∴ Order of filter

$$N = \frac{\log\sqrt{\frac{10^{0.1\alpha_s}-1}{10^{0.1\alpha_p}-1}}}{\log\frac{\Omega_s}{\Omega_p}}$$

$= \log\sqrt{\frac{10^{0.1(10)}-1}{10^{0.1(3)}-1}} = \frac{\log 3}{\log 3.25}$

$= \frac{0.4771}{0.5118}$

$= 0.932$

∴ $N=1$

The transfer function of high pass filter

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

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

Using bilinear transformation

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

$$= \frac{S}{S+7265}\Bigg|_{s=\frac{2}{2\times10^{-4}}\left(\frac{1-z^{-1}}{1+z^{-1}}\right)}$$

$$= \frac{10000\left(\frac{1-z^{-1}}{1+z^{-1}}\right)}{10000\left(\frac{1-z^{-1}}{1+z^{-1}}\right)+7265}$$

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