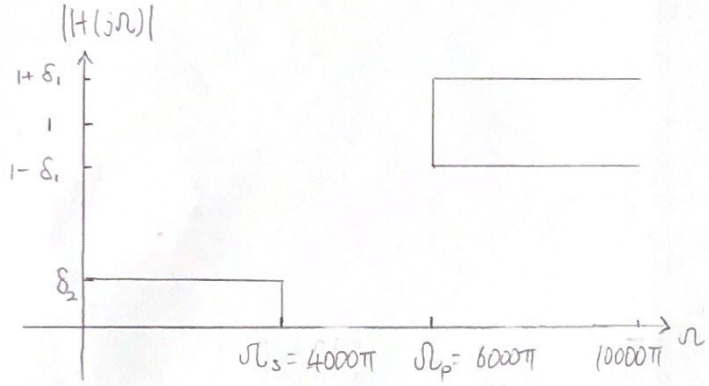
Allister Lin.

a) The input $x_c(t)$ should be band limited to $\frac{1}{2}(10000) = 5000$ Hz to avoid ~~out~~ aliasing.

b)



$\delta_1 = 0.001$

$\delta_2 = 0.001$

$\omega = T\Omega \rightarrow \Omega = \frac{\omega}{T}$

$\frac{1}{T} = 10000 \rightarrow T = \frac{1}{10000}$

$\therefore$ ~~$\Omega_s = \frac{0.4\pi}{10000}$, $\Omega_p = \frac{0.6\pi}{10000}$~~

$\Omega_s = 4000\pi$, $\Omega_p = 6000\pi$

c) No, impulse invariance cannot be used, because it may result in aliasing. ** The continous high pass filter is not band limited.

$\lim_{s\to\infty}$ $H(s) \neq 0$. $\rightarrow$ denominator of H $\leq$ numerator of H.

d) Yes,

$$\begin{cases} |H(j\Omega)| \leq 0.001 & 0 \leq \Omega \leq \frac{2}{T_d}\tan\left(\frac{0.4\pi}{2}\right) \\ 0.999 \leq H(j\Omega) \leq 1.001 & \frac{2}{T_d}\tan\left(\frac{0.6\pi}{2}\right) \leq \Omega \leq \infty \end{cases}$$

e) Yes.

$$A = -20 \log_{10} \delta = -20 \log_{10}(0.001) = 60.$$

$$\therefore \beta = \begin{cases} 0.1102(A-8.7) & A > 50 \\ 0.5842(A-21)^{0.4} + 0.07886(A-21) & 21 \le A < 50 \\ 0.0 & A < 21 \end{cases}$$

$$M = \frac{A-8}{2.285\,\Delta w}$$

$$\therefore \beta = 0.1102(60-8.7) = 5.65326$$

$$M = \frac{60-8}{2.285(0.2\pi)} = 36.219 \approx 37. \quad \text{(rounding up).}$$

$$\Delta w = 0.6\pi - 0.4\pi = 0.2\pi$$

$$h[n] = \frac{\sin(0.6\pi(n-\frac{M}{2})) - \sin(0.4\pi(n-\frac{M}{2}))}{\pi(n-\frac{M}{2})} \quad \text{where } M = 37.$$

f) Yes.

~~Max group delay of 14 samples.~~

~~$14 \times 10^{-4} = 1.4\text{ms}$.~~

$$\alpha = \frac{M}{2} = 18.5 \text{ samples.}$$