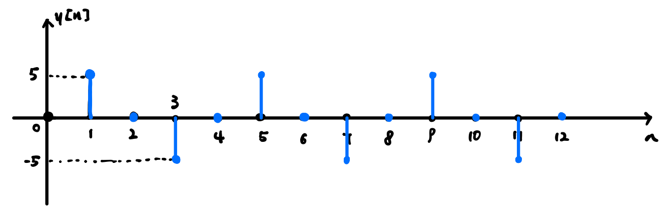
[1]. $x[n] \longrightarrow \boxed{\downarrow 3} \longrightarrow y[n]$

(a) $x[n] = 5\sin(\frac{\pi}{6}n)$, $y[n] = x[3n] = 5\sin(\frac{\pi}{2}n)$



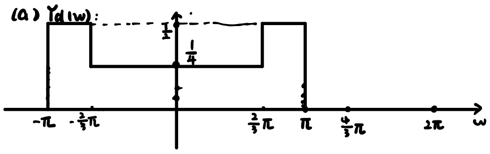
(b) $X_d(w) = \dfrac{1}{1-\frac{1}{2}e^{-jw}}$, $x[n] = (\frac{1}{2})^n u[n]$

$y[n] = x[3n] = (\frac{1}{2})^{3n}\cdot u[3n] = (\frac{1}{8})^n \cdot u[n]$

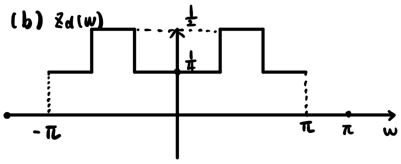
so $Y_d(w) = \dfrac{1}{1-\frac{1}{8}e^{-jw}}$

[2] $x[n] \longrightarrow \boxed{\downarrow 4} \longrightarrow y[n] \longrightarrow \boxed{\uparrow 2} \longrightarrow z[n]$

(a) $Y_d(w)$:



(b) $Z_d(w)$

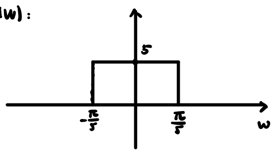


[3]

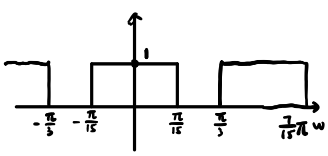
(a)

$x[n] \longrightarrow \boxed{\uparrow N=5} \longrightarrow \boxed{H_d(w)} \longrightarrow \boxed{\downarrow M=3} \longrightarrow y[n]$

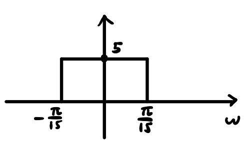
$H_d(w)$:



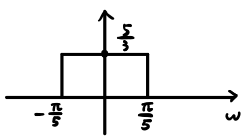
(b) after upsampling:



after $H_d(w)$:



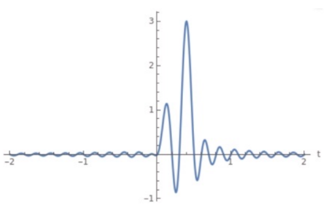
after downsampling:



[4] $x[n] = \delta[n-1] + 3\delta[n-4]$, $T = \frac{1}{10}$

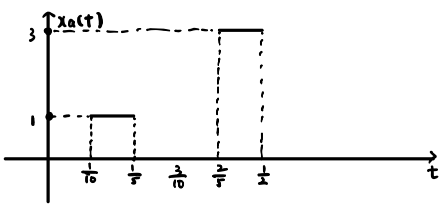
(a) ideal D/A converter:

$$x_a(t) = \sum_{n=-\infty}^{\infty} x[n]\,\mathrm{sinc}\left(\frac{\pi(t-nT)}{T}\right)$$
$$= \mathrm{sinc}\left(\frac{\pi(t-T)}{T}\right) + 3\,\mathrm{sinc}\left(\frac{\pi(t-4T)}{T}\right)$$

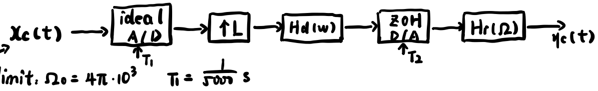


(b) ZOH:

$$x_a(t) = \sum_{n=-\infty}^{\infty} x[n]\,g(t-nT) = g(t-T) + 3g(t-4T)$$



[5].



bandlimit: $\Omega_0 = 4\pi \cdot 10^3$ $\quad T_1 = \frac{1}{5000}$ s

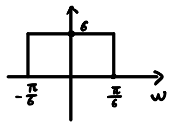
(a) $L=1$, $\quad w = \Omega T = \frac{4}{5}\pi$

i. $T_2 = T_1 = \frac{1}{5000}$ s should be a proper choice

ii. bandwidth: $\frac{2(\pi - \frac{4}{5}\pi)}{T_2} = 2000\pi$

(b) $L=6$, $\quad w = \Omega T = \frac{4}{5}\pi$

i. Hd(w):



ii. $w = \Omega T$, $\quad T_2 = \frac{w}{\Omega} = \frac{\frac{4}{5}\pi \cdot \frac{1}{6}}{4\pi \cdot 10^3} = \frac{1}{30000}$ s

iii. bandwidth: $\frac{2(\pi - \frac{2}{15}\pi)}{T_2} = 52000\pi$