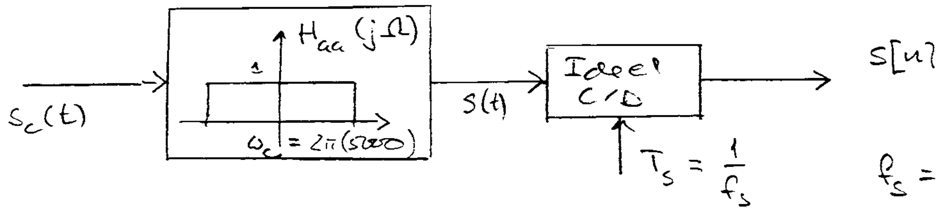
Opg 4.37



$f_s = 10$ [kHz]

$T_s = 10^{-4}$ [s]

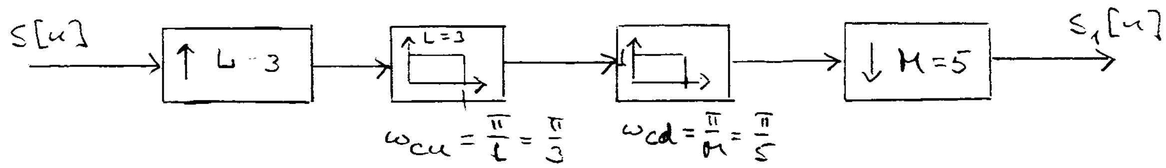
Givet $s[n]$

Ønsket: Det signal $s_1[n]$, der ville være fremkommet, hvis $s_c(t)$ var blevet filtreret med $\omega_c = 2\pi\cdot(3000)$ og samplet med $f_{s1} = 6$ [kHz]. ~ $T_{s1} = \frac{5}{3}\cdot 10^{-4}$ [s]

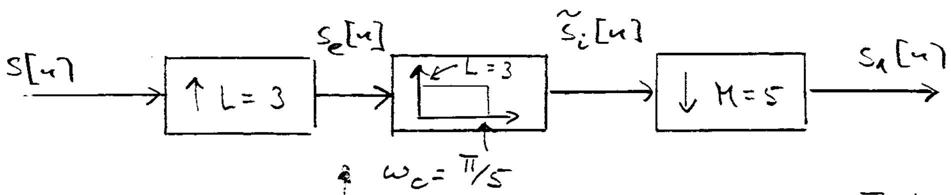
$\Omega_N = 5.000$ [Hz] $\quad \Omega_{N1} = 3.000$ [Hz]

$f_s = 10.000$ [Hz] $\quad f_{s1} = 6.000$ [Hz]

Det ses, at $f_{s1} = \frac{3}{5}\cdot f_s$ og $T_{s1} = \frac{5}{3} T_s$



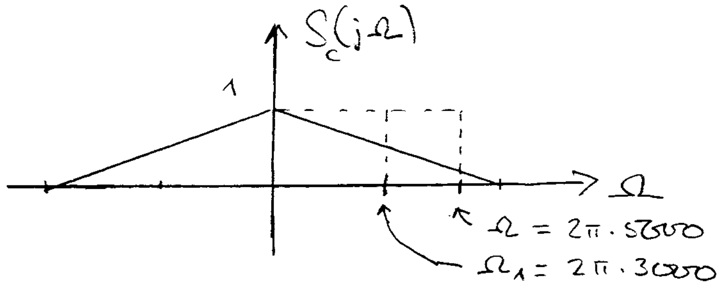
Lavpasfilteret erstattes af ét med $\omega_c = \min(\omega_{cu}, \omega_{cd}) = \frac{\pi}{5}$ og gain L.

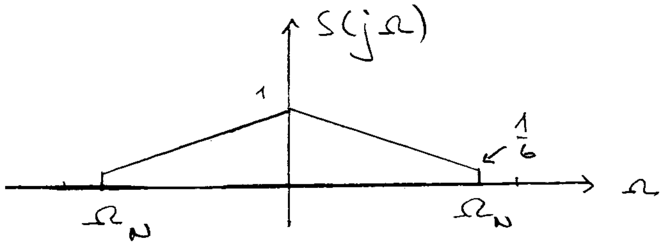


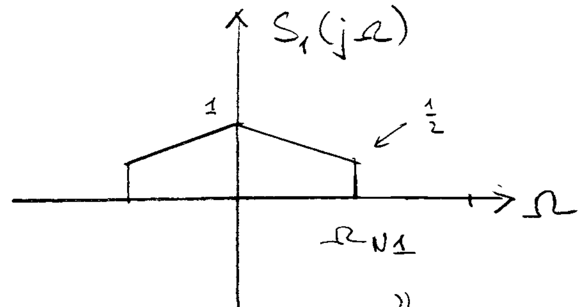
T_s	$T_s' = T_s/L$	$T_s' = T_s/L$	$T_s'' = \frac{T_s\cdot M}{L}$
f_s	$f_s' = L\cdot f_s$	$f_s' = L\cdot f_s$	$f_s'' = \frac{L\cdot f_s}{M}$

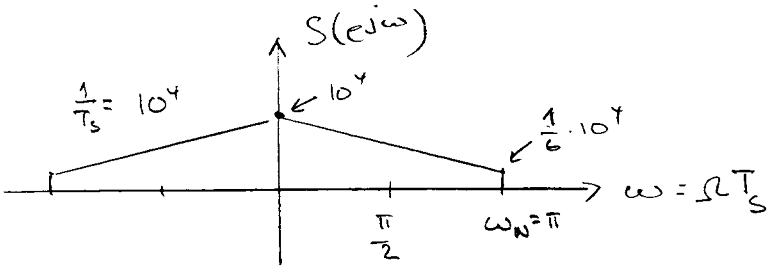
$T_s = 10^{-4}\ [s]$

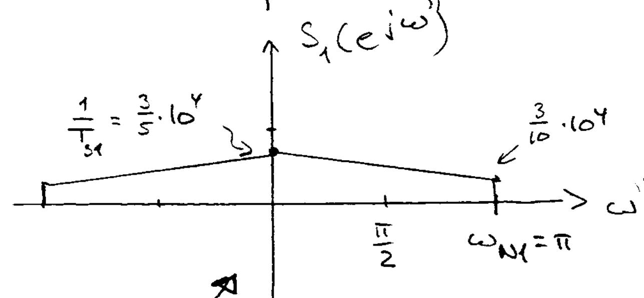
$T_{s1} = \frac{5}{3} \cdot 10^{-4}\ [s]$









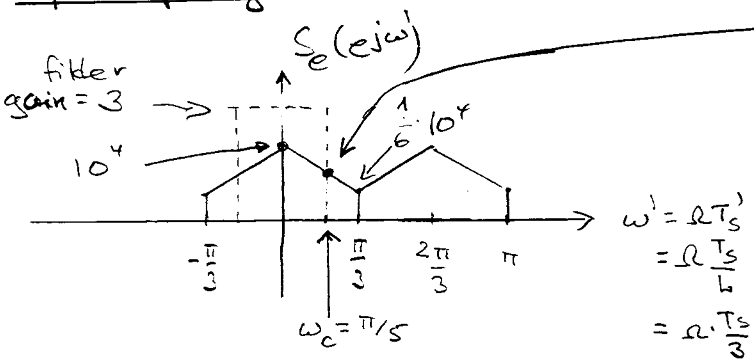


← Haves   Ønskes

$$\omega_N = \Omega_N \cdot T_s = 2\pi \cdot 5000 \cdot 10^{-4} = \pi$$

$$\omega_{N1} = \Omega_N \cdot T_{s1} = 2\pi \cdot 3000 \cdot \frac{5}{3} \cdot 10^{-4} = \pi$$

Upsampling $L = 3$

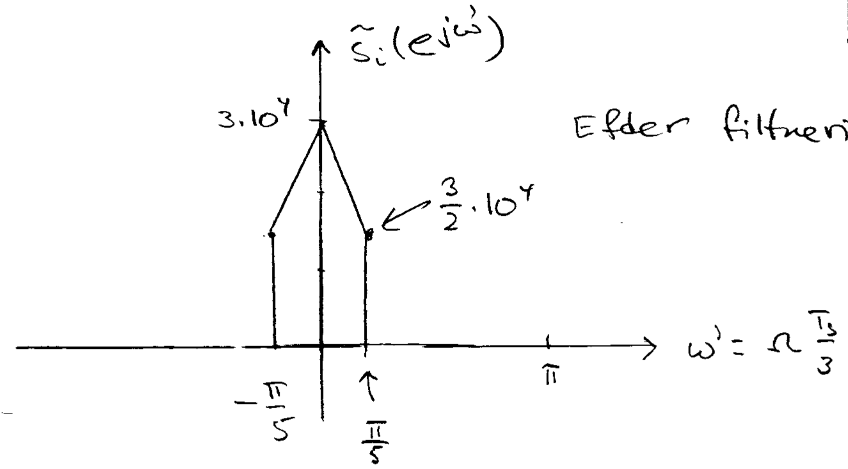


$y = \alpha x + q \qquad q = 10^4$

$$\alpha = \frac{\frac{1}{6} \cdot 10^4 - 10^4}{\frac{\pi}{3} - 0} = \frac{-\frac{5}{6} \cdot 10^4}{\frac{\pi}{3}} = -\frac{5}{2\pi} \cdot 10^4$$

$$y = -\frac{5}{2\pi} \cdot 10^4 x + 10^4$$

$$y\left(\frac{\pi}{5}\right) = -\frac{5}{2\pi} \cdot 10^4 \cdot \frac{\pi}{5} + 10^4 = \left(-\frac{1}{2} + 1\right) 10^4 = \frac{1}{2} \cdot 10^4$$

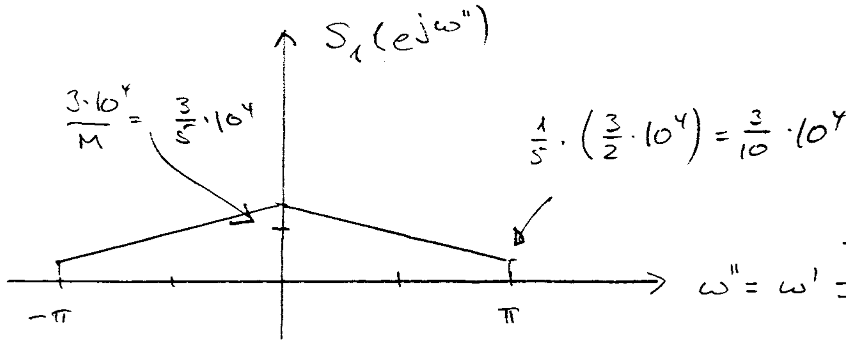


Efter filtrering

Downsampling $M = 5$

$$f_s'' = 5 f_s'$$

$$T_s'' = \frac{1}{5} T_s'$$



$$\omega'' = \omega' \frac{T_s''}{T_s'} = \omega' \frac{f_s''}{f_s'} = \omega' \frac{5 f_s'}{f_s} = 5\omega' = \frac{5\cdot \Omega T_s}{3}$$

$$\omega'' = \Omega \cdot T_s'' = \Omega \cdot \frac{T_s \cdot M}{L}$$

Dette spektrum er identisk med det direkte opnåede mærket "ønskes".