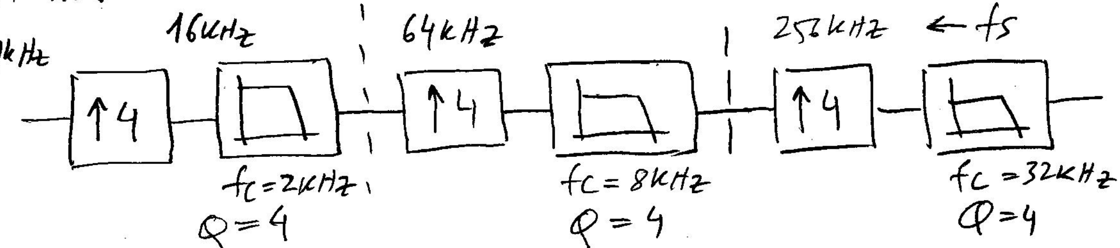
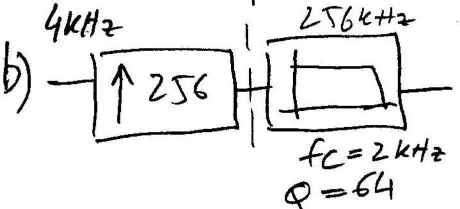
SPDS – 3ª Série de problemas I-) 1/3/1/2/4/2/2
SEPS

II – $f_s = 4kHz \rightarrow 256kHz$, $L = \frac{256}{4} = 64 = 4^3 \Rightarrow$ 3 estágios com $L=4$

Since the input sampling frequency is $f_s = 4kHz$, the maximum signal bandwidth is $B = \frac{f_s}{2} = 2kHz$. There is no loss of information because decimation is not involved.

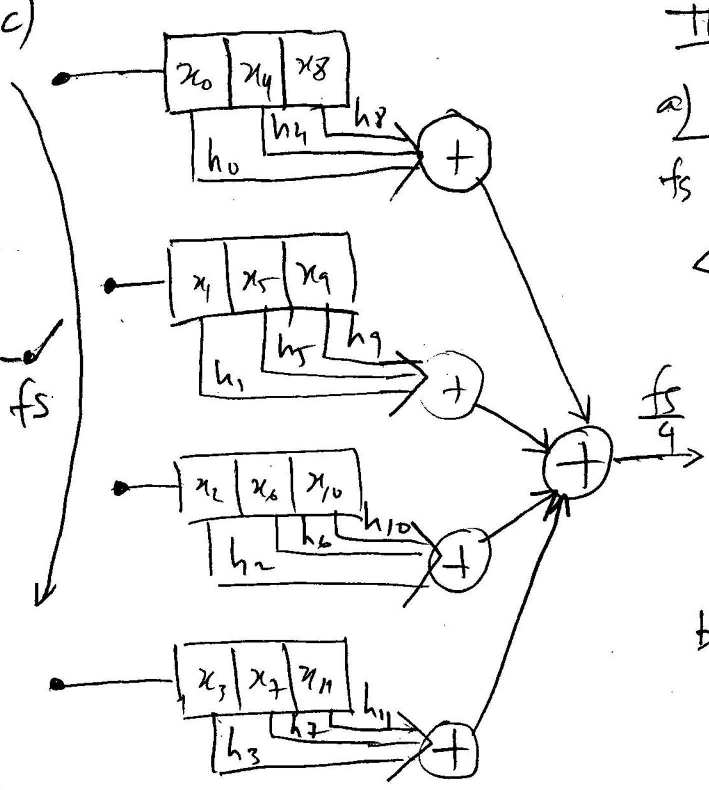


b)



Complexity is proportional to the filter quality factor. With one stage $C = Q = 64$. With 3 stages $C = 3 \times 4 = 12$, $\frac{64}{12} = 5.333$ more economical

c)



No memory economy.
$\frac{N}{M} = \frac{12}{4} = 3\times$ computational economy

d)

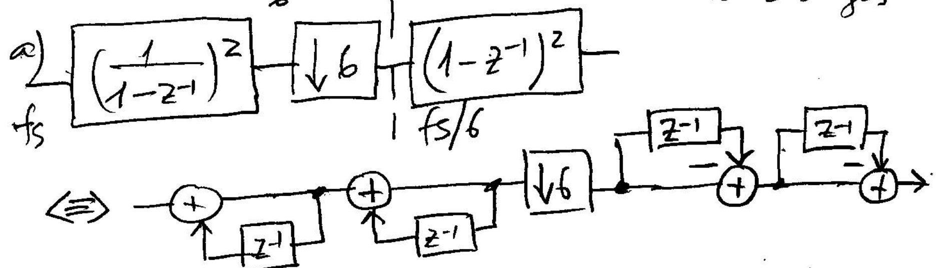
inserts L-1 zeros for every input sample

$x_0 - x_1, x_1 - x_2, \ldots$

reduces memory locations from L to 1, and the comb filter is processed at the lower rate.

III – $f_s \rightarrow \frac{f_s}{6}$, $M=6$ using A.A. CIC filter $N=2$ stages

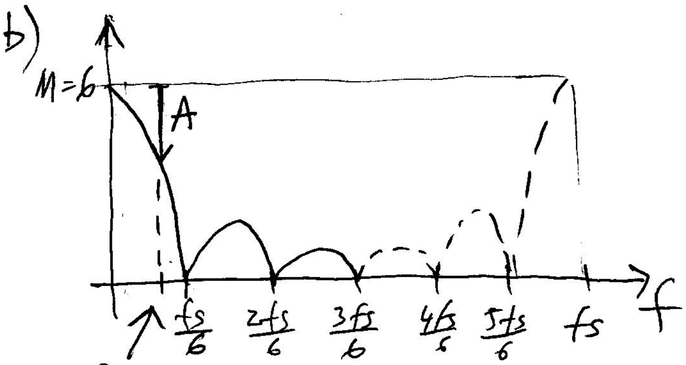
a)



⊕ Simple, easy to replicate, no multiplications, no coefficient memory, linear phase

⊖ lack of flexibility of the filtering function, input signal needs to be oversampled (at least 2x)

b)



$$\frac{f_s}{M} - B = \frac{f_s}{6} - \frac{f_s}{24} = \frac{3f_s}{24} = \frac{f_s}{8},$$

$$|H(\omega)| = \left|\frac{\sin\frac{M\omega T_s}{2}}{\sin\frac{\omega T_s}{2}}\right|, \quad A = \frac{|H(0)|}{|H(\omega)|_{\omega = 2\pi\left(\frac{f_s}{M} - B\right)}} =$$

$$= 6\left|\frac{\sin \pi/8}{\sin 6\pi/8}\right| = 3.2472 = 10.23\ dB/\text{stage}$$

To achieve 50dB, $N=5$ Stages are required the actual attenuation is 51.15 dB