Esercizio 1

$$x_1(t) = B \,\mathrm{sinc}^2(Bt)$$

$$x_2(t) = \sum_n x_0(t - nT_0)$$

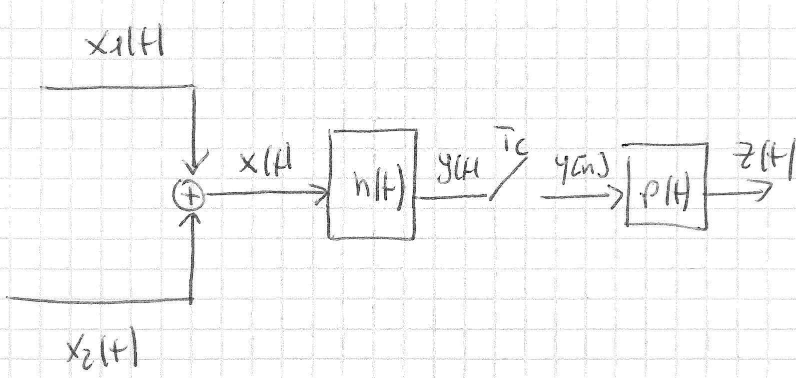
$$x_0(t) = \mathrm{rect}\left(\frac{t}{T}\right)$$

$$T_0 = \frac{2}{B} \qquad 0 < T < T_0$$

$$T_c = \frac{4}{3B}$$

$$h(t) = \frac{3}{2} B \,\mathrm{sinc}\left(\frac{3}{2}Bt\right)$$

$$p(t) = \frac{3}{4} B \,\mathrm{sinc}\left(\frac{3}{4}Bt\right)$$

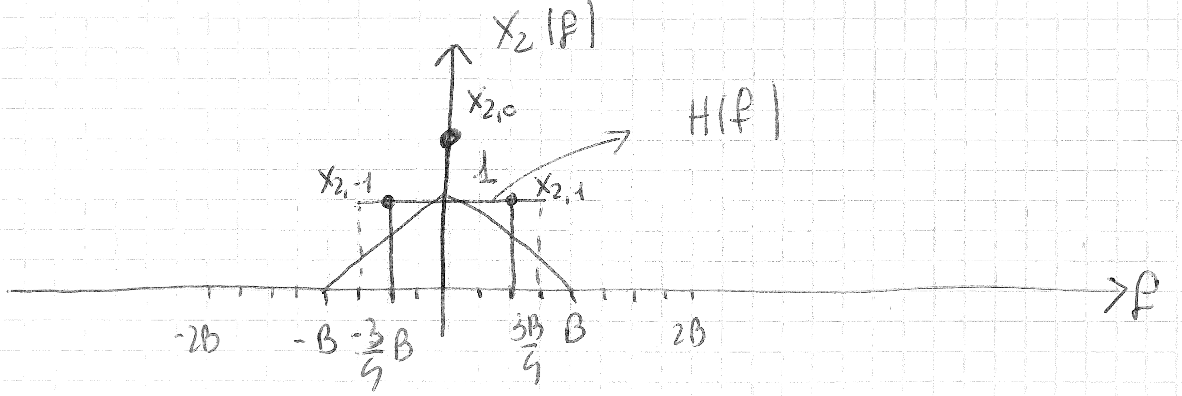


$$x(t) = x_1(t) + x_2(t)$$

$$X_1(f) = \left(1 - \frac{|f|}{B}\right) \mathrm{rect}\left(\frac{f}{2B}\right)$$

$$X_0(f) = T \,\mathrm{sinc}(fT)$$

$$X_2(f) = \frac{T}{T_0} \sum_n \mathrm{sinc}\left(T\frac{n}{T_0}\right) \delta\left(f - \frac{n}{T_0}\right)$$



$$X_{2,0} = \frac{T}{T_0}$$

$$X_{2,1} = X_{2,-1} = \frac{T}{T_0} \operatorname{sinc}\left(\frac{T}{T_0}\right)$$

perché la funzione sinc è pari.

$$H(f) = \operatorname{rect}\left(\frac{f}{3B/2}\right)$$

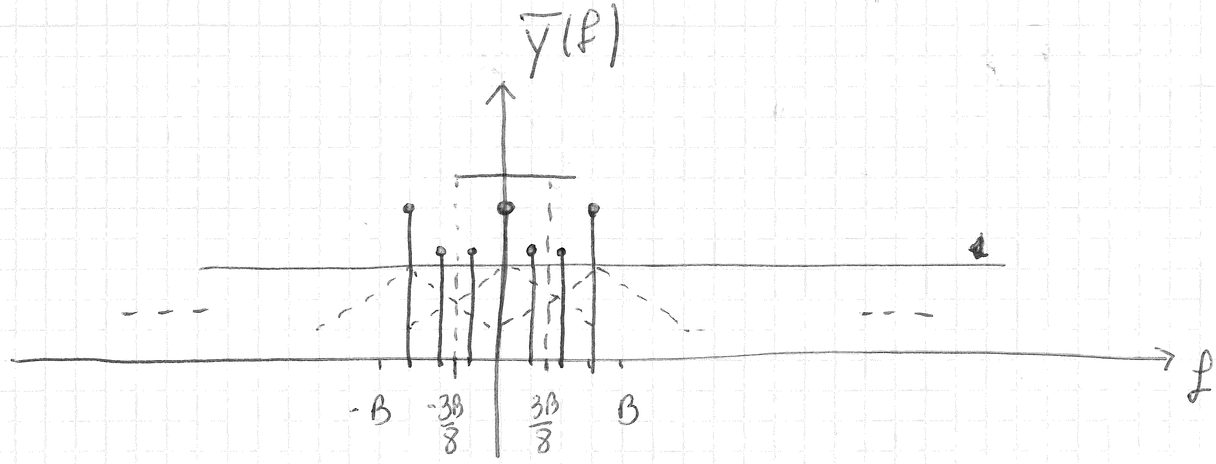
$$Y(f) = \left(1 - \frac{|f|}{B}\right) \operatorname{rect}\left(\frac{f}{2B}\right) \cdot \operatorname{rect}\left(\frac{f}{3B/2}\right) + X_{2,0}\,\delta(f) +$$

$$X_{2,1}\,\delta\left(f - \frac{B}{2}\right) + X_{2,1}\,\delta\left(f + \frac{B}{2}\right)$$

$$\overline{Y}(f) \rightleftharpoons y[n]$$

$$\overline{Y}(f) = \frac{1}{T_C} \sum_n Y\left(f - \frac{n}{T_C}\right)$$

periodo è $\frac{1}{T_C} = \frac{3B}{4}$



$$P(f) = \operatorname{rect}\left(\frac{f}{3B/4}\right)$$

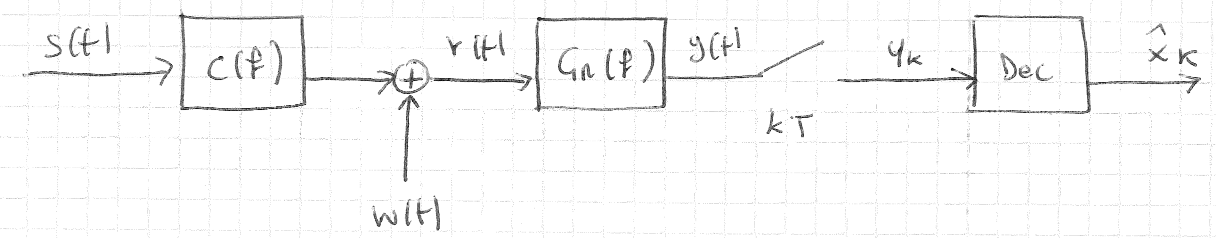
$$Z(f) = \frac{1}{T_C}\,\mathrm{rect}\left(\frac{f}{3B/4}\right) + \frac{1}{T_C}X_{2,0}\,\delta(f) + \frac{1}{T_C}X_{2,1}\left(\delta\left(f-\frac{B}{4}\right)+\delta\left(f+\frac{B}{4}\right)\right)$$

$E_z = +\infty$ perché le segnale ha componenti periodiche

$$P_z = \left(\frac{1}{T_C}X_{2,0}\right)^2 + 2\cdot\left(\frac{1}{T_C}X_{2,1}\right)^2$$

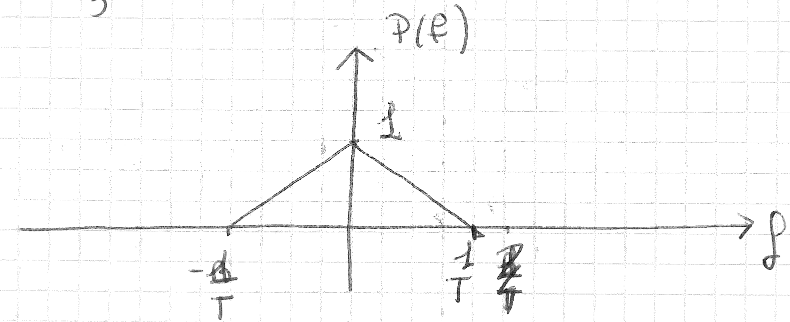
perché la Potenza media della componente ~~con~~ non periodica è nulla.

Esercizio 2

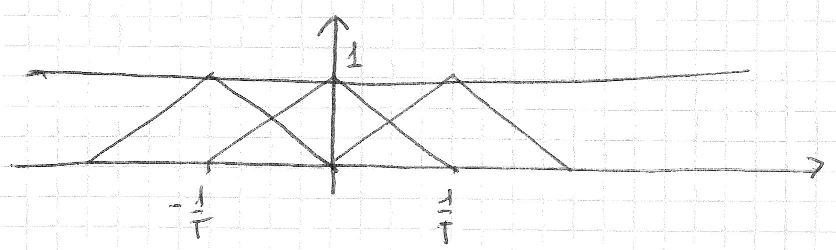


1) $E_s = (-2)^2 \cdot \frac{2}{3} \cdot E_p + (1)^2 \cdot \frac{1}{3} E_p$

$$E_p = \int_{-\infty}^{+\infty} P(f)^2\,df = \frac{1}{T}$$



2) $H(f) = P(f)\cdot G_R(f)\cdot C(f) = P(f)^2$



Essendo il periodo di ripetizione pari a $\frac{1}{T}$ le funzioni triangolari si sommano generando una costante.

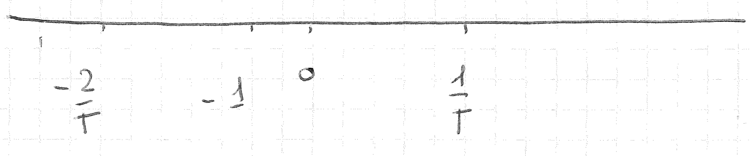
$$h(0) = \int_{-\infty}^{+\infty} H(f)\, df = \frac{1}{T}$$

3) Sia la densità spettrale di potenza del rumore in uscita al filtro in ricezione, $S_n(f)$

$$S_n(f) = S_w(f) \cdot |G_R(f)|^2$$

$$P_n = \int_{-\infty}^{+\infty} S_n(f)\, df = \frac{N_0}{2} \int_{-\infty}^{+\infty} G_R^2(f)\, df = \frac{N_0}{2T}$$

4) $y_K = h(0)\, x_K + \cancel{h_m}\, n_K \qquad n_K \in \mathcal{N}(0, \sigma) \qquad \sigma = \frac{N_0}{2T}$



$$P_E(b) = \frac{2}{3} Q\left(\frac{-1 + \frac{2}{T}}{\sqrt{N_0/2T}}\right) + \frac{1}{3} Q\left(\frac{\frac{1}{T} + 1}{\sqrt{N_0/2T}}\right) =$$

$$= \frac{2}{3} Q\left(\frac{2-T}{T} \sqrt{\frac{2T}{N_0}}\right) + \frac{1}{3} Q\left(\frac{1+T}{T} \sqrt{\frac{2T}{N_0}}\right) =$$

$$= \frac{2}{3} Q\left(\sqrt{\frac{(2-T)^2 \cdot 2}{T N_0}}\right) + \frac{1}{3} Q\left(\sqrt{\frac{(1+T)^2 \cdot 2}{T N_0}}\right)$$