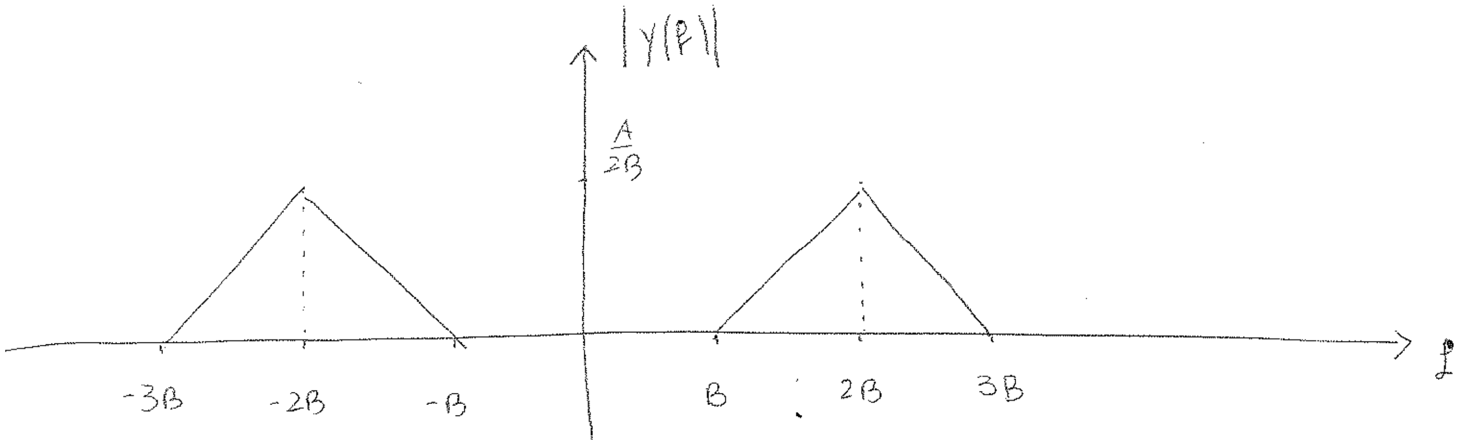
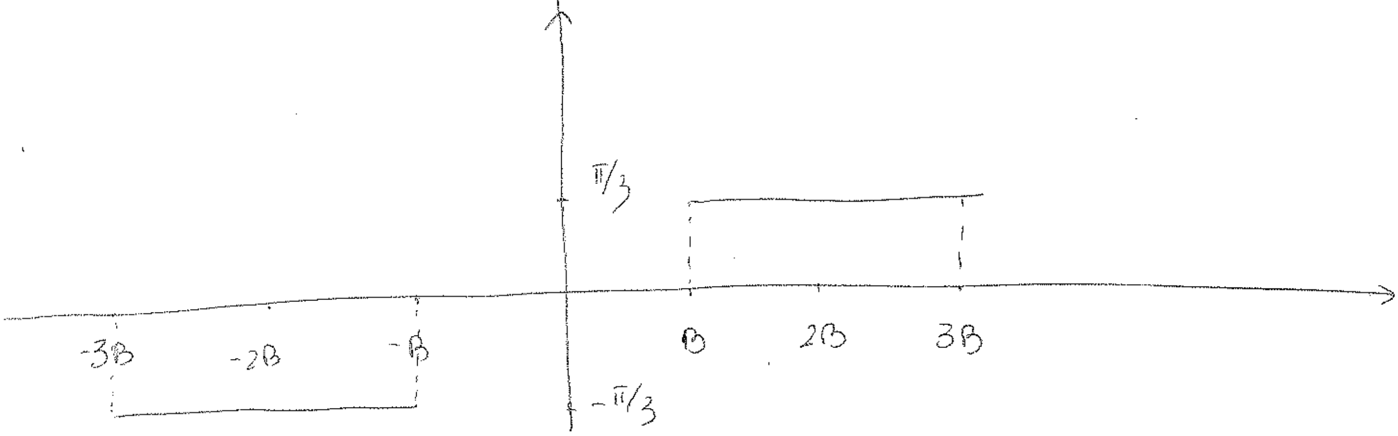
1

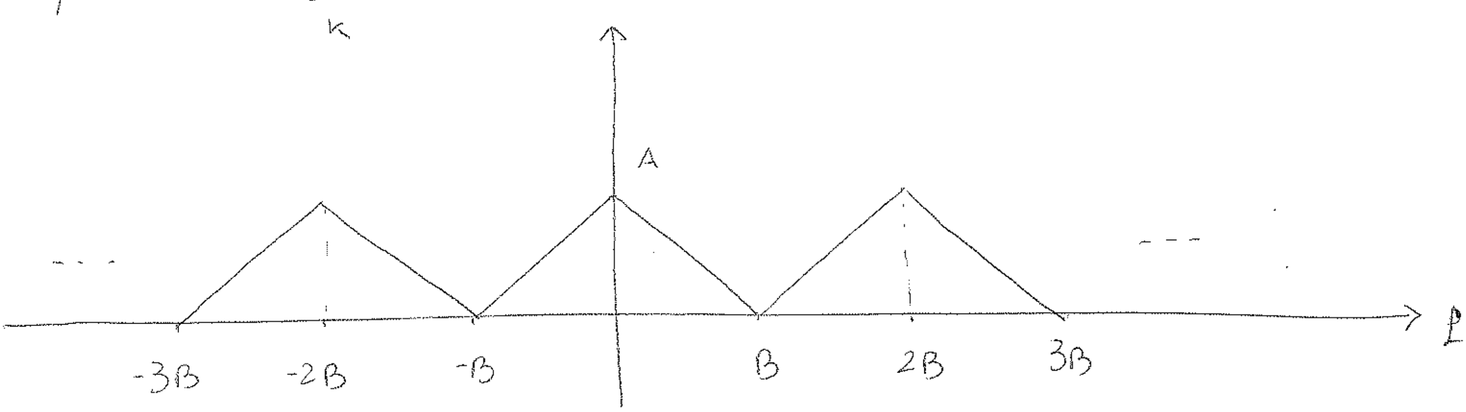
$$X(f) = \frac{A}{B}\left(1 - \frac{|f|}{B}\right)\mathrm{rect}\left(\frac{f}{2B}\right)$$

$$Y(f) = \frac{A}{B}\left(1 - \frac{|f|}{B}\right)\mathrm{rect}\left(\frac{f}{2B}\right) \otimes \left[\frac{e^{i\pi/3}}{2}\,\delta(f - f_0) + \frac{e^{-i\pi/3}}{2}\,\delta(f + f_0)\right]$$



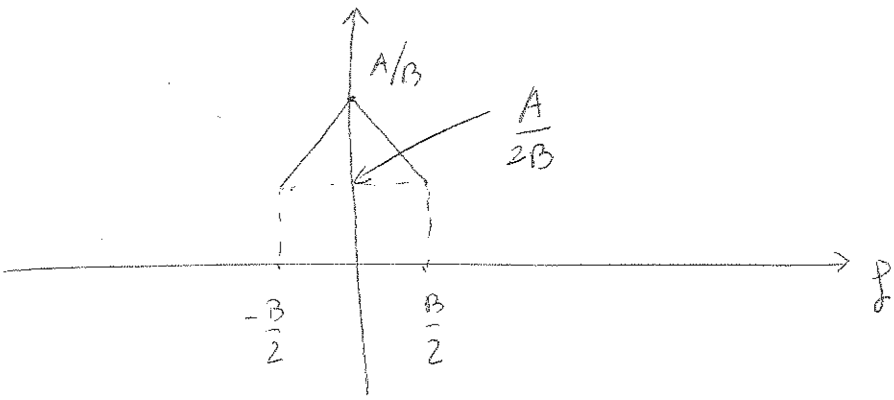




$$\bar{Y}(f) = 2B \sum_k Y(f - k2B)$$



$$P(f) = \frac{1}{B}\,\mathrm{rect}\left(\frac{f}{B}\right)$$

$$Z(f) = \bar{Y}(f)\,P(f) = A\left(1-\frac{|f|}{B}\right)\mathrm{rect}\left(\frac{f}{B}\right)$$




$$Z(f) = \frac{A}{2B}\,\mathrm{rect}\left(\frac{f}{B}\right) + \frac{A}{2B}\left(1-\frac{|f|}{2B}\right)\mathrm{rect}\left(\frac{f}{B}\right)$$

$$z(t) = \frac{A}{2}\,\mathrm{sinc}\left(Bt\right) + \frac{A}{4}\,\mathrm{sinc}^2\left(\frac{B}{2}t\right)$$

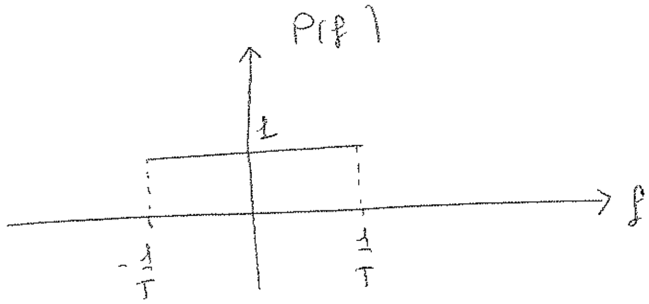
$$P_z = 0$$

$$E_z = \int_{-\infty}^{+\infty} |Z(f)|^2\,df = \frac{A^2}{4B^{\cancel{2}}}\cdot\cancel{B} + \frac{A^2}{4B^{\cancel{2}}}\cdot\frac{\cancel{B}}{\cancel{2}}\cdot\frac{\cancel{2}}{3} + \cancel{2}\,\frac{A^{2}}{4B^2}\cdot\frac{\cancel{B}}{\cancel{2}} =$$

$$= \frac{A^2}{4B} + \frac{A^2}{12B} + \frac{A^2}{4B} = \frac{7}{12}\frac{A^2}{B}$$

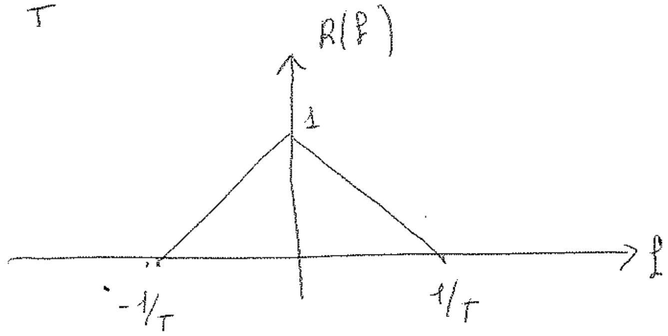
(2)

1) $P(f) = \text{rect}\left(\frac{f}{2/T}\right)$




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

$$R(f) = \left(1 - |f|T\right) \text{rect}\left(\frac{f}{2/T}\right)$$




$$\sigma_n^2 = \frac{N_0}{2} \int R^2(f)\, df = \frac{N_0}{2} \cdot \frac{1}{T} \cdot \frac{2}{3} = \frac{N_0}{3T}$$

$$H(f) = P(f)\, R(f) = R(f)$$

Risposta impulsiva del sistema che soddisfa la condizione di Nyquist

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

Dopo il comparatore il simbolo è

$$y_k = h(0)\, a_k + n_k$$

$$P(e) = 2Q\left(\frac{1/T}{\sqrt{\frac{N_0}{3T}}}\right) = 2Q\left(\sqrt{\frac{3}{N_0 T}}\right)$$

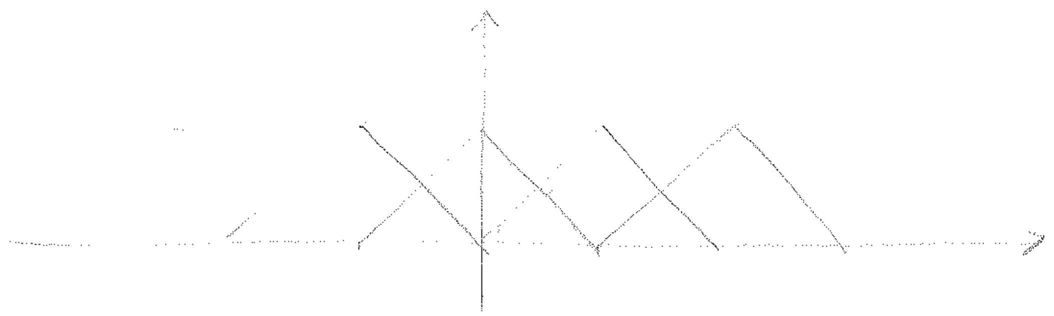
2) $P(f) = \sqrt{2\left(1-|f|T\right)\mathrm{rect}\left(f/2T\right)}$

$$E_S = E_p = \int_{-\infty}^{+\infty} P^2(f) = 2\int_{-\infty}^{+\infty}\left(1-|f|T\right)\mathrm{rect}\left(\frac{f}{2/T}\right) = \frac{2}{T}$$

$$R(f) = \sqrt{\left(1-|f|T\right)\mathrm{rect}\left(f/2T\right)}$$

$$\sigma_n^2 = \frac{N_0}{2}\int R^2(f)\,df = \frac{N_0}{2T}$$

$$H(f) = P(f)\,R(f) = \sqrt{2}\left(1-|f|T\right)\mathrm{rect}\left(\frac{f}{2/T}\right)$$



soddisfa la condizione di Nyquist

$$h(0) = \int_{-\infty}^{+\infty} H(f)\,df = \frac{\sqrt{2}}{T}$$

$$P_E(b) = 2Q\left(\frac{\sqrt{2}}{T}\frac{1}{\sqrt{\frac{N_0}{2T}}}\right) = 2Q\left(\sqrt{\frac{4}{N_0 T}}\right)$$

3)

$$2Q\left(\sqrt{\frac{4}{N_0T}}\right) < 2Q\left(\sqrt{\frac{3}{N_0T}}\right)$$

Infatti nel secondo caso il ricevitore e' il ricevitore ottimo in quando il filtro in ricezione e' adattato all'impulso trasmesso.