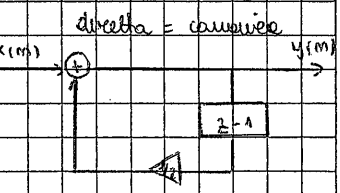
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COMPITO 20/12/16 - FILA B / 1) Dato sistema puramente ricorsivo caratterizzato dall'eq. alle differenze $y(n) = \frac{1}{2} y(n-1) + x(n)$. Calcola la funzione di trasferimento del sistema e fare il grafico della forma canonica. Scrivere espressione della risposta impulsiva causale e la relativa zona di convergenza. Fare grafico della risposta in frequenza del sistema e dire di che tipo è il sistema in esame. Scrivere risposta del sistema alla sequenza $x(n) = n \left(\frac{1}{4}\right)^n u(n)$

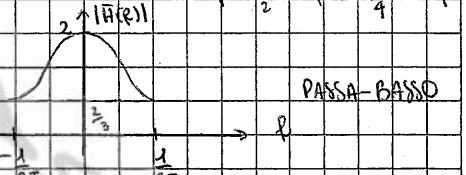
- $Y(z) = \frac{1}{2} z^{-1} Y(z) + X(z) \Rightarrow H(z) = \frac{Y(z)}{X(z)} = \frac{1}{1 - \frac{1}{2} z^{-1}} = \frac{z}{z - \frac{1}{2}}$



- $h(n) = \left(\frac{1}{2}\right)^n u(n) \quad |z| > \frac{1}{2}$
- Poiché la circonferenza di raggio unitario fa parte della zona di convergenza posso calcolare:

$$\bar{H}(f) = \frac{1}{1 - \frac{1}{2} e^{-j2\pi f T}} = \frac{1}{1 - \frac{1}{2}\cos 2\pi f T + \frac{1}{2} j \sin 2\pi f T} \qquad |\bar{H}(f)| = \frac{1}{\sqrt{\left(1 - \frac{1}{2}\cos 2\pi f T\right)^2 + \frac{1}{4}\sin^2 2\pi f T}}$$

$$= \frac{1}{\sqrt{\frac{5}{4} - \cos 2\pi f T}} \qquad |\bar{H}(0)| = 2 \qquad |\bar{H}(\pm \tfrac{1}{2T})| = \frac{2}{3}$$



- $X(z) = \frac{1}{4} \frac{z}{(z - \frac{1}{4})^2} \qquad Y(z) = H(z) X(z) = \frac{1}{4} \frac{z^2}{(z - \frac{1}{2})(z - \frac{1}{4})^2}$

fratti semplici $Y(z) = \frac{A}{z - \frac{1}{2}} + \frac{B}{z - \frac{1}{4}} + \frac{C}{(z - \frac{1}{4})^2} \qquad A = \frac{1}{4} \frac{z^2}{(z - \frac{1}{4})^2}\Big|_{z = \frac{1}{2}} = 1$

$C = \frac{1}{4} \frac{z^2}{(z - \frac{1}{2})}\Big|_{z = \frac{1}{4}} = -\frac{1}{16}$ per calcolare B prendiamo $z = 0$

$0 = -2 - 1 - 4B \rightarrow B = -\frac{3}{4}$

dunque $Y(z) = \frac{1}{z - \frac{1}{2}} - \frac{3}{4} \frac{1}{z - \frac{1}{4}} - \frac{1}{16} \frac{1}{(z - \frac{1}{4})^2}$ antitrasformo $y(n) = \left(\frac{1}{2}\right)^{n-1} u(n-1) -$

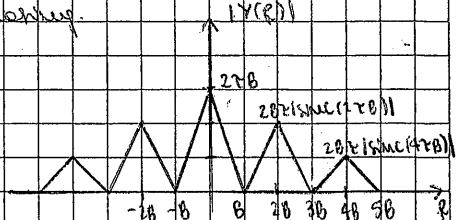
$$-\frac{3}{4}\left(\frac{1}{4}\right)^{n-1} u(n-1) - \frac{1}{4}(n-1)\left(\frac{1}{4}\right)^{n-1} u(n-1) = \left(\frac{1}{2}\right)^{n-1} u(n-1) - \frac{1}{4}(n+2)\left(\frac{1}{4}\right)^{n-1} u(n-1)$$

2) Il segnale passa-basso $x(t) = B \operatorname{sinc}^2(Bt)$ viene campionato con il segnale $c(t) = \sum_{n=-\infty}^{+\infty} \text{coll}(t - nT)$ con $\text{coll}(t) = \text{rect}(t/\tau)$ e $\tau < T$, $T = 1/2B$. Il segnale campionato $y(t) = x(t) c(t)$ viene filtrato con il passa-banda $H(f) = \text{rect}\left(\frac{f - 2B}{2B}\right) + \text{rect}\left(\frac{f + 2B}{2B}\right)$. Scrivere l'espressione dello spettro del segnale $y(t)$ e grafico. Scrivere espressione temporale del segnale $z(t)$ all'uscita del filtro.

- $Y(f) = X(f) \otimes C(f)$ dove $C(f) = \frac{1}{T} \sum_{k=-\infty}^{+\infty} \text{Coll}\left(\frac{k}{T}\right) \delta\left(f - \frac{k}{T}\right) \qquad \text{Coll}(f) = \tau \operatorname{sinc}(f\tau)$

$$C(f) = \frac{\tau}{T} \sum_{k=-\infty}^{+\infty} \operatorname{sinc}(\tau k \tau B)\, \delta(f - kB) \quad \text{da cui} \quad Y(f) = 2\tau B \sum_{k=-\infty}^{+\infty} \operatorname{sinc}(2kB\tau) X(f - 2kB)$$

perdi rispetto la convoluzione di Nyquist, non c'è aliasing.

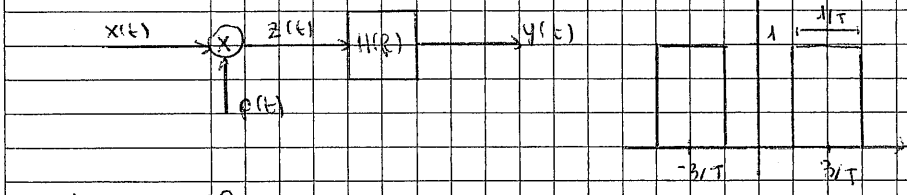


- $Z(f) = H(f) Y(f)$ il filtro passa-banda seleziona le repliche centrate in $\pm 2B$ cioè

$$Z(f) = 2B\tau \operatorname{sinc}(2B\tau)\left[X(f - 2B) + X(f + 2B)\right]$$

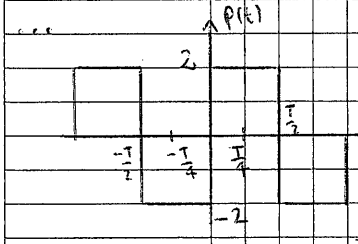
$$z(t) = 2B\tau \operatorname{sinc}(2B\tau)\left[x(t) e^{j2\pi 2Bt} + x(t) e^{-j2\pi 2Bt}\right] = 4B\tau \operatorname{sinc}(2B\tau)\, x(t) \cos(4\pi Bt)$$

COMPITO 10/01/19 1) Il segnale di ingresso è $x(t) = 1/4\ \mathrm{sinc}(t/T)$. Il segnale $p(t)$ è l'onda quadra $2\sum_{n=-\infty}^{+\infty} (\mathrm{rect}(t-T/4-nT) - \mathrm{rect}(t+T/4-nT))$. Dopo aver disegnato $p(t)$ si calcoli lo spettro del segnale $z(t) = p(t)\,x(t)$ e $\overline{T/2}$ se ne faccia il grafico del modulo. Il filtro $H(f)$ è passa-banda, si calcoli spettro e andamento temporale del segnale $y(t)$.



$X(f) = \mathrm{rect}(fT)$

• parto con il disegnare $p(t)$:



PERIODICO DI PERIODO T (ne calcolo la trasformata della versione per lo spettro di $z(t)$)

$$p_0(t) = 2\,\mathrm{rect}\left(\frac{t-T/4}{T/2}\right) - 2\,\mathrm{rect}\left(\frac{t+T/4}{T/2}\right)$$

$$p(t) = \sum_{k=-\infty}^{+\infty} p_0(t-kT)$$

$$P_0(f) = 2\frac{T}{2}\mathrm{sinc}\left(f\frac{T}{2}\right)e^{-j\pi f\frac{T}{2}} - 2\frac{T}{2}\mathrm{sinc}\left(f\frac{T}{2}\right)e^{j\pi f\frac{T}{2}} = T\,\mathrm{sinc}\left(f\frac{T}{2}\right)\left[\frac{e^{-j\pi f\frac{T}{2}} - e^{j\pi f\frac{T}{2}}}{-2j}\right](-2j) =$$

$$= -2Tj\,\mathrm{sinc}\left(f\frac{T}{2}\right)\mathrm{sin}\left(\pi f\frac{T}{2}\right)$$

$$\rightsquigarrow P_k = \frac{1}{T}P_0\left(\frac{k}{T}\right) = \frac{1}{T}\left(-2Tj\,\mathrm{sinc}\left(\frac{k}{T}\frac{T}{2}\right)\mathrm{sin}\left(\frac{k}{T}\frac{T}{2}\pi\right)\right) =$$

$$= -2j\,\mathrm{sinc}\left(\frac{k}{2}\right)\mathrm{sin}\left(\frac{k\pi}{2}\right)$$

$$P(f) = -2j\sum_{k=-\infty}^{+\infty}\mathrm{sinc}\left(\frac{k}{2}\right)\mathrm{sin}\left(\frac{k\pi}{2}\right)\delta\left(f-\frac{k}{T}\right)$$

$$Z(f) = X(f) \otimes P(f) = -2j\sum_{k=-\infty}^{+\infty}\mathrm{sinc}\left(\frac{k}{2}\right)\mathrm{sin}\left(\frac{k\pi}{2}\right)\frac{\mathrm{rect}\left(\frac{f-k/T}{1/T}\right)}{1/T}$$

$P_0 = -2j\,\mathrm{sinc}(0)\,\mathrm{sin}(0) = 0$

$P_1 = -2j\,\mathrm{sinc}(\pi/4)\cdot\frac{2}{\pi}\mathrm{sin}\frac{\pi}{2} = -\frac{4j}{\pi}$

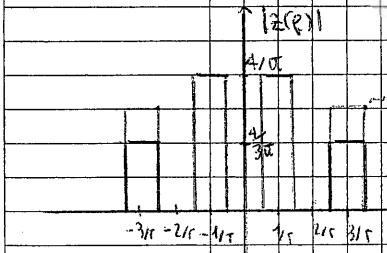
$P_{-1} = -2j\,\mathrm{sinc}(-\pi/4)\cdot(-2/\pi)\,\mathrm{sin}(-\pi/4) = \frac{4j}{\pi}$

$P_2 = 0 = P_{-2}$

$P_3 = -2j\,\mathrm{sinc}(3\pi/2)(2/3\pi)\,\mathrm{sin}(3\pi/4) = -\frac{4j}{3\pi}$ ...

$P_{-3} = -2j\,\mathrm{sinc}(-3\pi/2)(-2/3\pi)\,\mathrm{sin}(-3\pi/4) = \frac{4j}{3\pi}$

per il modulo di $Z(f)$ basta prendere il modulo dei coefficienti trovati:



• $Y(f) = Z(f)\cdot H(f)$ ⇝ devo prendere solo le rect in $-3/T$ e $3/T$ di $Z(f)$

$$\Rightarrow Y(f) = -\frac{4j}{3\pi}\frac{\mathrm{rect}\left(\frac{f-3/T}{1/T}\right)}{1/T} + \frac{4j}{3\pi}\frac{\mathrm{rect}\left(\frac{f+3/T}{1/T}\right)}{1/T} =$$

$$= \frac{4j}{3\pi}\left[\frac{\mathrm{rect}\left(\frac{f+3/T}{1/T}\right) - \mathrm{rect}\left(\frac{f-3/T}{1/T}\right)}{1/T}\right]$$

antitrasformo e ottengo $y(t)$:

$$y(t) = \frac{4j}{3\pi}\left[\frac{1}{T}\mathrm{sinc}\left(\frac{t}{T}\right)e^{-j6\pi\frac{t}{T}} - \frac{1}{T}\mathrm{sinc}\left(\frac{t}{T}\right)e^{j6\pi\frac{t}{T}}\right] = \frac{4j}{3\pi T}\mathrm{sinc}\left(\frac{t}{T}\right)\left[\frac{e^{-j6\pi\frac{t}{T}} - e^{j6\pi\frac{t}{T}}}{-2j}\right](-2j) =$$

$$= \frac{8}{3\pi T}\mathrm{sinc}\left(\frac{t}{T}\right)\mathrm{sin}\left(6\pi\frac{t}{T}\right)$$

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2) Sia dato il sistema LTI caratterizzato dalla seguente equazione differenziale: $\frac{d^2y(t)}{dt^2} + 3\frac{dy(t)}{dt} + 2y(t) = x(t)$.

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All'ingresso di tale sistema viene posto il segnale esponenziale $x(t) = 2e^{-3t}u(t)$. Si calcolino la risposta in frequenza $H(f)$ e l'uscita $h(t)$ del sistema (se esiste) e si tracci il grafico del modulo di $H(f)$. Si calcoli la banda a -3dB del sistema (se esiste). Si calcoli l'espressione $y(t)$ del segnale d'uscita corrispondente al segnale d'ingresso dato. Si supponga che di voler ricostruire l'equivalente digitale del sistema assegnato (a meno di casi particolari precedenti) tramite invarianza della risposta impulsiva. Fissando il tempo di campionamento $T = 1$ sec, si scriva la risposta impulsiva e la frequenza $\bar{H}(f)$ del nuovo sistema digitale. Dopo aver valutato $|\bar{H}(0)|$ e $|\bar{H}(\pm 1/2T)|$, si tracci il grafico di $|\bar{H}(f)|$.

- $H(f) = \dfrac{Y(f)}{X(f)}$ per cui $(j2\pi f)^2 Y(f) + 3(j2\pi f)Y(f) + 2Y(f) = X(f)$ pongo $x = j2\pi f$

$\hookrightarrow Y(f) = \dfrac{X(f)}{x^2+3x+2}$ da cui $H(f) = \dfrac{1}{x^2+3x+2}$ $\quad x^2+x+2=0$, $\Delta = 9-8 = 1$, $x_{1,2} = \dfrac{-3 \pm 1}{2}$ (/ -2, \ -1)

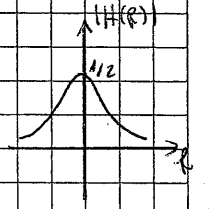
PROPRIA

$H(f) = \dfrac{1}{(x+2)(x+1)} = \dfrac{A_1}{x+2} + \dfrac{A_2}{x+1}$ $\quad A_1 = \dfrac{1}{x+1}\Big|_{x=-2} = -1$; $A_2 = \dfrac{1}{x+2}\Big|_{x=-1} = 1$

ripristino x

$\Rightarrow H(f) = -\dfrac{1}{x+2} + \dfrac{1}{x+1} = \dfrac{1}{j2\pi f+1} - \dfrac{1}{j2\pi f+2} \iff h_a(t) = e^{-t}u(t) - e^{-2t}u(t)$

- $|H(f)| = \dfrac{1}{\sqrt{(4\pi^2 f^2+1)(4\pi^2 f^2+4)}}$ $\quad |H(0)| = \dfrac{1}{2} \cdot \dfrac{1}{(4\pi^2 f^2+1)(4\pi^2 f^2+4)} \cdot 4 = \dfrac{1}{2}$



$8 = (4\pi^2 f^2+1)(4\pi^2 f^2+4)$ pongo $x = 4\pi^2 f^2 \Rightarrow 8 = (x+1)(x+4)$ da cui

$x^2+5x+4 = 8 \to x^2+5x-4=0$ $\quad \Delta = 25+16 = 41$ $\quad x_{1,2} = \dfrac{-5 \pm \sqrt{41}}{2}$ (/ 0,7 unica sol. da considerare perché positiva, \ )

adesso $4\pi^2 f^2 = 0.7 \to f = \pm\sqrt{\dfrac{0.7}{4\pi^2}} = \pm 0.13$ Hz $\Rightarrow B_{-3dB} = 0.13$

- calcolo $X(f) = \dfrac{2}{3+j2\pi f}$ $\rightsquigarrow Y(f) = X(f)H(f) = \dfrac{2}{(3+j2\pi f)(2+j2\pi f)(1+j2\pi f)} = \dfrac{A_1}{x+1} + \dfrac{A_2}{x+2} + \dfrac{A_3}{x+3}$ PROPRIA

con $x = j2\pi f$ come prima $\quad A_1 = \dfrac{2}{(x+2)(x+3)}\Big|_{x=-1} = 1$ $\quad A_2 = \dfrac{2}{(x+1)(x+3)}\Big|_{x=-2} = -2$

$A_3 = \dfrac{2}{(x+1)(x+2)}\Big|_{x=-3} = +1$ $\quad Y(f) = \dfrac{1}{j2\pi f+1} - \dfrac{2}{j2\pi f+2} + \dfrac{1}{j2\pi f+3}$ adesso antitrasformo

$y(t) = e^{-t}u(t) - 2e^{-2t}u(t) + e^{-3t}u(t)$

- $H_a(s) = H(f)\Big|_{s=j2\pi f} = \dfrac{1}{(s+2)(s+1)} = \dfrac{1}{s+1} - \dfrac{1}{s+2}$

$h_a(t) = e^{-t}u(t) - e^{-2t}u(t)$

$h_a(m) = T h_a(mT) = T e^{-mT}u(m) - e^{-2mT}u(m)$ $\quad (h_a(0^+) = a = h_a(0^-) = h_a(0)$ non ho discontinuità in 0)

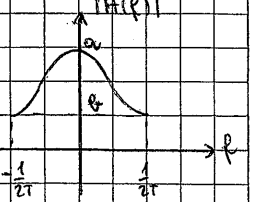
con $T = 1$ sec $\Rightarrow$

$h_a(m) = e^{-m}u(m) - e^{-2m}u(m) \iff H(z) = \dfrac{z}{z-e^{-1}} - \dfrac{z}{z-e^{-2}} = \dfrac{z(e^{-1}-e^{-2})}{(z-e^{-1})(z-e^{-2})}$

$\bar{H}(f) = H(z)\Big|_{z=e^{j2\pi fT}} = \dfrac{e^{j2\pi fT}(e^{-1}-e^{-2})}{(e^{j2\pi fT}-e^{-1})(e^{j2\pi fT}-e^{-2})}$

PASSA-BASSO

- $|\bar{H}(f)| = \dfrac{(e^{-1}-e^{-2})}{\sqrt{(1+e^{-2}+e^{-1}2\cos 2\pi fT)(1+e^{-2}+2e^{-2}\cos 2\pi fT)}}$



$|\bar{H}(0)| = \dfrac{e^{-1}-e^{-2}}{(1-e^{-1})(1-e^{-2})} = a$

$|\bar{H}(\pm 1/2T)| = e^{-1}-e^{-2}/(1+e^{-1})(1+e^{-2}) = b < a$

$x(t) = \sum_{n=-\infty}^{+\infty} x_0(t - nT)$ $\quad x_0(t) = \mathrm{rect}\left(\frac{t}{T}\right) + \mathrm{tri}\left(\frac{t}{T/2}\right) \quad Ex = \infty$

$= \left(1 - \frac{|t|}{T/4}\right) \mathrm{rect}\left(\frac{t}{T/2}\right)$

$P_x = \frac{1}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}} |x_0(t)|^2 dt = \frac{1}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}} \left(\mathrm{rect}\left(\frac{t}{T}\right) + \left(1 - \frac{|t|}{T/4}\right)\mathrm{rect}\left(\frac{t}{T/2}\right)\right)^2 dt =$

$x_0(t) \leftrightarrow X_0(f) = T\,\mathrm{sinc}(fT) + \frac{T}{4}\,\mathrm{sinc}^2\left(f\frac{T}{4}\right)$

$X_k = \frac{1}{T} X_0\left(\frac{k}{T}\right) = \frac{1}{T} T\,\mathrm{sinc}\left(k\frac{T}{T}\right) + \frac{1}{T}\frac{T}{4}\,\mathrm{sinc}^2\left(\frac{k}{T}\frac{T}{4}\right) =$

$= \mathrm{sinc}(k) + \frac{1}{4}\mathrm{sinc}^2\left(\frac{k}{4}\right)$

$X(f) = \sum_{k=-\infty}^{+\infty} \left[\mathrm{sinc}(k) + \frac{1}{4}\mathrm{sinc}^2\left(\frac{k}{4}\right)\right] \delta\left(f - \frac{k}{T}\right)$

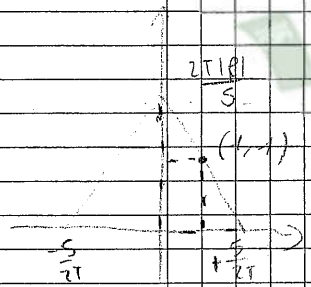
$k = 0, \pm 1, \pm 2$ $\quad X_k = \mathrm{sinc}(0) + \frac{1}{4}\mathrm{sinc}^2(0) = 1 + \frac{1}{4} = \frac{4+1}{4} = \frac{5}{4}$

$X_k = \mathrm{sinc}(1) + \frac{1}{4}\mathrm{sinc}^2\left(\frac{1}{4}\right) = \frac{\sin\pi}{\pi} + \frac{1}{4}\frac{\sin^2\left(\frac{\pi}{4}\right)}{\left(\frac{\pi}{4}\right)^2} = \frac{1}{4}\frac{4^2}{\pi^2}\frac{\sin^2\left(\frac{\pi}{4}\right)}{\left(\frac{1}{2}\right)^2} = \frac{2}{\pi^2}$

$X_k = \mathrm{sinc}(-1) + \frac{1}{4}\mathrm{sinc}^2\left(-\frac{1}{4}\right) = \frac{1}{4}\frac{\sin^2\left(-\frac{\pi}{4}\right)}{\left(-\frac{\pi}{4}\right)^2} = \frac{1}{4}\frac{4^2}{\pi^2}\left(\frac{\sqrt{2}}{2}\right)^2 = \frac{2}{\pi^2}$

$\cdots$

$\frac{2T|f|}{5}\left(1 - \frac{|f|}{5/2T}\right)\mathrm{rect}\left(\frac{f}{\frac{5}{2T}}\right)$



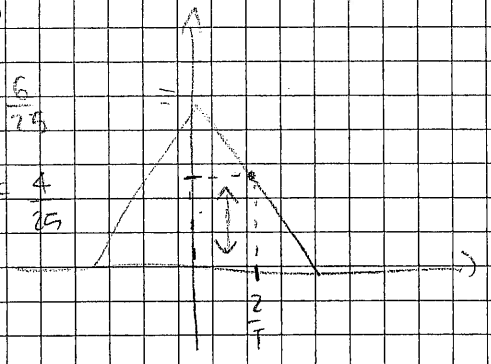
$Y(f) = \frac{2}{T^2}\left[\delta\left(f - \frac{1}{T}\right) + \delta\left(f + \frac{1}{T}\right)\right] - \frac{6}{2S} \cdots$

$y(t)$

$H(0) = 0$

$H\left(\frac{1}{T}\right) = H\left(-\frac{1}{T}\right) = \frac{6}{2S}$

$H\left(\frac{2}{T}\right) = H\left(-\frac{2}{T}\right) = \frac{4}{2S}$



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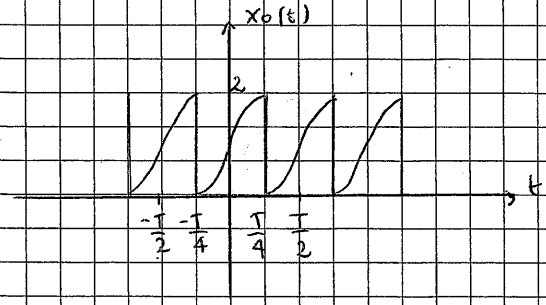
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TDS

12/11/18

COMPITINO A

1) $x(t) = \sum_{m=-\infty}^{+\infty} x_0\left(t - m\frac{T}{2}\right)$ $\quad x_0(t) = \left[1 + \sin\left(\frac{2\pi t}{T}\right)\right] \text{rect}\left(\frac{2t}{T}\right)$ $\quad$ PERIODO $= T_0 = \frac{T}{2}$



ENERGIA INFINITA (periodico)

$$P_x = \frac{2}{T}\int_{-\frac{T}{4}}^{\frac{T}{4}} \left[1 + \sin\left(\frac{2\pi t}{T}\right)\right]^2 dt =$$

$$= \frac{2}{T}\int_{-\frac{T}{4}}^{\frac{T}{4}} \left(1 + \sin^2\left(\frac{2\pi t}{T}\right) + 2\sin\left(\frac{2\pi t}{T}\right)\right) dt =$$

$$= \frac{2}{T}\int_{-\frac{T}{4}}^{\frac{T}{4}} \left[\frac{5}{2} - \frac{1}{2}\cos\left(\frac{4\pi t}{T}\right) + 2\sin\left(\frac{2\pi t}{T}\right)\right] dt = \frac{5}{2}$$

$$x_0(t) = \text{rect}\left(\frac{2t}{T}\right) + \text{rect}\left(\frac{2t}{T}\right)\sin\left(\frac{2\pi t}{T}\right)$$

$$X_0(f) = \frac{T}{2}\text{sinc}\left(f\frac{T}{2}\right) + \frac{T}{4j}\text{sinc}\left(\frac{T}{2}\left(f - \frac{1}{T}\right)\right) - \frac{T}{4j}\text{sinc}\left(\frac{T}{2}\left(f + \frac{1}{T}\right)\right)$$

$$X_k = \frac{2}{T}X_0\left(\frac{2k}{T}\right) = \text{sinc}(k) + \frac{1}{2j}\text{sinc}\left(k - \frac{1}{2}\right) - \frac{1}{2j}\text{sinc}\left(k + \frac{1}{2}\right)$$

$X_0 = \text{sinc}(0) + \frac{1}{2j}\text{sinc}\left(-\frac{1}{2}\right) - \frac{1}{2j}\text{sinc}\left(-\frac{1}{2}\right) = 1$ $\quad$ per $k = 0$

$X_1 = \frac{1}{2j}\text{sinc}\left(\frac{1}{2}\right) - \frac{1}{2j}\text{sinc}\left(\frac{3}{2}\right) = \frac{4}{3j\pi}$ $\quad$ per $k = 1$

$X_{-1} = -\frac{4}{3j\pi}$ $\quad$ per $k = -1$

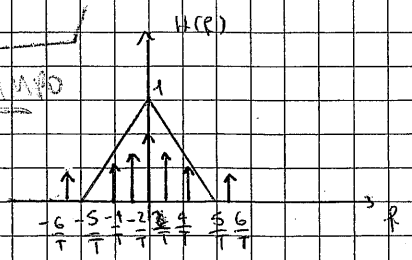
$X_2 = \frac{1}{2}\text{sinc}\left(\frac{3}{2}\right) - \frac{1}{2j}\text{sinc}\left(\frac{5}{2}\right) = -\frac{8}{15j\pi}$ $\quad$ per $k = 2$

$X_{-2} = \frac{8}{15j\pi}$ $\quad$ per $k = -2$

$$X(f) = \sum_{k=-\infty}^{+\infty}\left(\text{sinc}(k) + \frac{1}{2j}\text{sinc}\left(k - \frac{1}{2}\right) - \frac{1}{2j}\text{sinc}\left(k + \frac{1}{2}\right)\right)\delta\left(f - \frac{2k}{T}\right)$$

$H(f) = \text{rect}\left(\frac{f}{10/T}\right)$ BANDA 5 $\quad$ FORMULA UNICA

$$Y(f) = H(f)X(f) = X_0\,\delta(f) + H\left(\frac{2}{T}\right)X_1\,\delta\left(f - \frac{2}{T}\right) + H\left(-\frac{2}{T}\right)X_{-1}\,\delta\left(f + \frac{2}{T}\right) + H\left(\frac{4}{T}\right)X_2\,\delta\left(f - \frac{4}{T}\right) + H\left(-\frac{4}{T}\right)X_{-2}\,\delta\left(f + \frac{4}{T}\right)$$



$H\left(\pm\frac{2}{T}\right) = \frac{3}{5}$ $\quad H\left(\pm\frac{4}{T}\right) = \frac{1}{5}$

$$Y(f) = \delta(f) + \frac{4}{5j\pi}\delta\left(f - \frac{2}{T}\right) - \frac{4}{5j\pi}\delta\left(f + \frac{2}{T}\right) - \frac{8}{15j\pi}\delta\left(f - \frac{4}{T}\right) + \frac{8}{15j\pi}\delta\left(f + \frac{4}{T}\right)$$

$$\left(1 - \frac{1}{5/T}\right) = \left(1 - \frac{2}{5T}\right) = \frac{5-2}{5} = \frac{3}{5}$$

$$H\left(\frac{2}{T}\right) = \text{rect}\left(\frac{2}{T}\frac{T}{10}\right) = \text{rect}\left(\frac{1}{5}\right)$$

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