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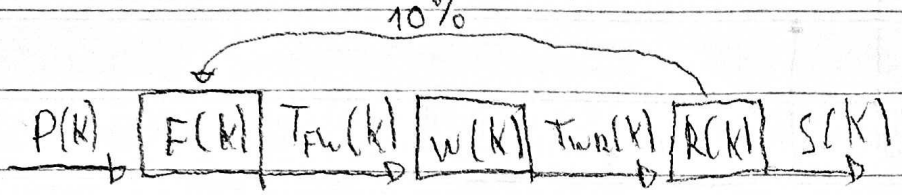
1) $x[k] = \begin{bmatrix} F[k] \\ W[k] \\ R[k] \end{bmatrix} \Leftrightarrow y[k] = x[k]$ $\quad u[k] = \begin{bmatrix} T_{FW}[k] \\ T_{WR}[k] \end{bmatrix}$ produtos enviados

$d[k] = \begin{bmatrix} P[k] \\ S[k] \end{bmatrix}$ perturbação

produtos não enviados (armazenados)



$F[k+1] = F[k] + P[k] + 0,1 \cdot R[k] - T_{FW}[k]$

$W[k+1] = W[k] + T_{FW}[k] - T_{WR}[k]$

$R[k+1] = R[k] + T_{WR}[k] - 0,1 R[k] - S[k] = 0,9 \cdot R[k] + T_{WR}[k] - S[k]$

Modelo a tempo discreto: $x[k+1] = Ax[k] + B_1 \cdot u[k] + B_2 \cdot d[k]$, $y[k] = C \cdot x[k]$

Como $x[k] = \begin{bmatrix} F[k] \\ W[k] \\ R[k] \end{bmatrix}$, logo $x[k+1] = \begin{bmatrix} F[k+1] \\ W[k+1] \\ R[k+1] \end{bmatrix}$, então:

$$x[k+1] = \underbrace{\begin{bmatrix} 1 & 0 & 0,1 \\ 0 & 1 & 0 \\ 0 & 0 & 0,9 \end{bmatrix}}_{A} \cdot x[k] + \underbrace{\begin{bmatrix} -1 & 0 \\ 1 & -1 \\ 0 & 1 \end{bmatrix}}_{B_1} \cdot u[k] + \underbrace{\begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & -1 \end{bmatrix}}_{B_2} \cdot d[k]$$

$y[k] = x[k]$

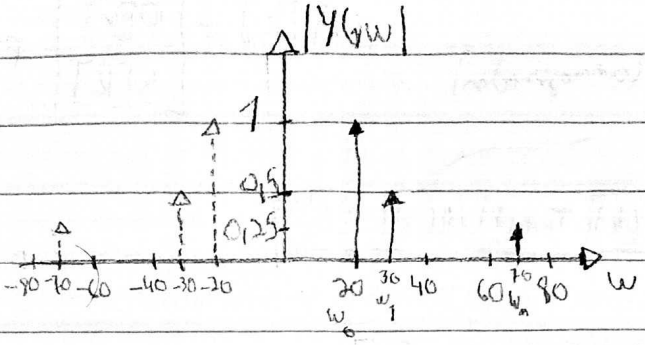
2) $x(t) = 2\sin(\omega_0 t) + \sin(\omega_1 t)$, $\omega_0 = 20$ rad/s

ruído $n(t) = 0{,}5 \cdot \sin(\omega_n t)$ $\omega_1 = 30$ rad/s

$\omega_n = 70$ rad/s

$y(t) = x(t) + n(t) = 2 \cdot \sin(20t) + \sin(30t) + 0{,}5 \cdot \sin(70t)$

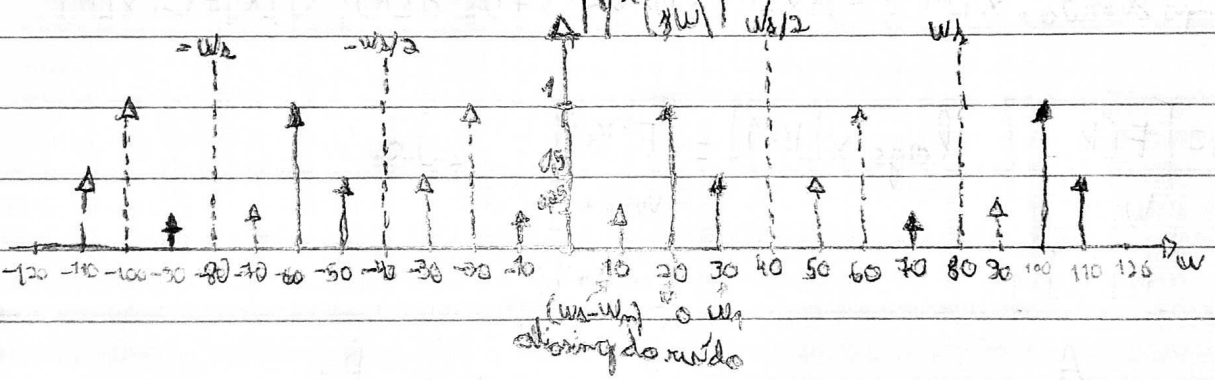
a) i)



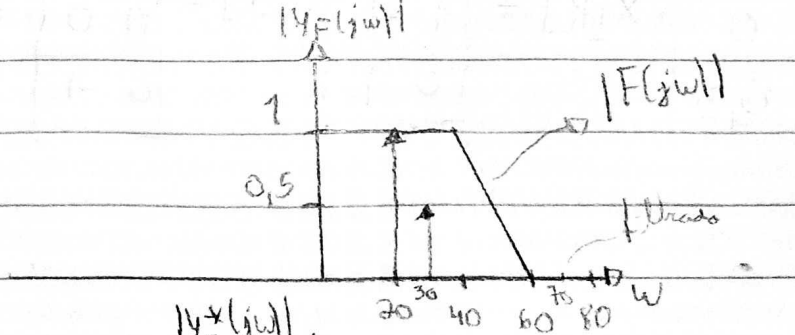
ii) $T = \pi/40 \Rightarrow \omega_s = \frac{2\pi}{T} = 80$ rad/s $2\omega_0 < \omega_s$,

$2\omega_1 < \omega_s$,

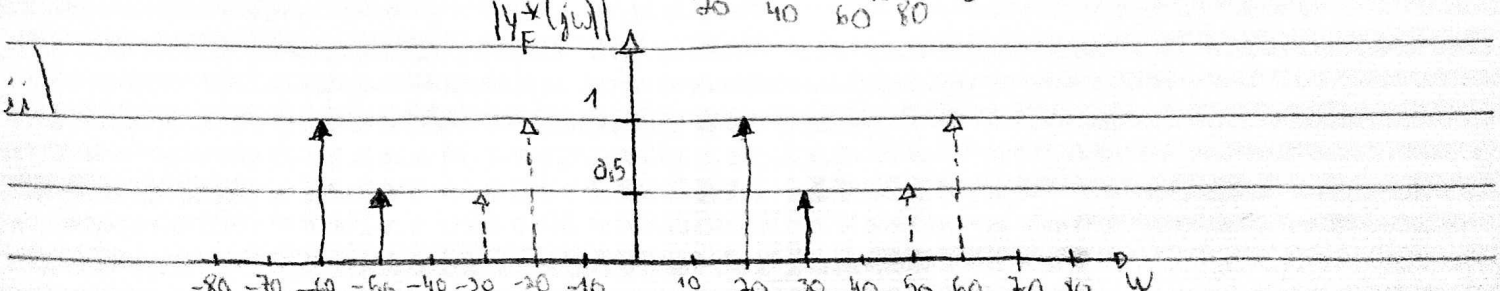
$2\omega_n > \omega_s$, aliasing, recuperada em $\omega_s - \omega_n = 10$ rad/s



b) i) $\alpha = 90$, $\omega_F = 40$ rad/s $\Rightarrow \omega_F + \frac{1}{\alpha} = 60$ rad/s



ii)



$2\omega = 120 = \frac{2\pi}{T} \Rightarrow T = \frac{\pi}{60}$

iii) Como $\omega_F + \frac{1}{\alpha} = 60$ rad/s logo o maior período de amostragem é $\pi/60$.