Freq 1 (Exemplo de Questões)

① $x(t) = \underset{\uparrow \atop 0}{2} + 3\sin(\underset{\uparrow \atop 1}{t})\cos(2t) + 5\sin(\underset{\uparrow \atop 4}{4t}) - \cos(\underset{\uparrow \atop 3}{3t})$

R: $\omega \in \{0, 1, 3, 4\}$

② $\omega \in \{8\pi, 16\pi, 20\pi\}$

$\omega_0 = \text{mdc}(\omega) = 4\pi$

$\omega_0 = \dfrac{2\pi}{T_0} \Leftrightarrow T_0 = 2\pi/\omega_0 = 2\pi/4\pi = 1/2$

③ $x(t) = 4\cos(2t)^2 = 4\left[\dfrac{1+\cos(4t)}{2}\right] = 2 + 2\cos(4t)$

$y(t) = 2 + 2\cos(4t)$

④ $x(t) = 2\cos(4\pi t)$

$E = \int_{-2}^{2} |x(t)|^2 = \int_{-2}^{2} |4\cos(4\pi t)|^2$ ← Energia finita
Potência nula

⑤ $x(t) = 2 + 4\sin(3t) \quad x(-t) = 2 + 4\sin(-3t) = 2 - 4\sin(3t)$

↑ Nem par nem ímpar

$x(t) = 4\sin(3t)^2 \quad x(-t) = 4\sin(-3t)^2 = 4\sin(3t)^2$

↑ Par

$x(t) = 2 + 4\cos(2t) \quad x(-t) = 2 + 4\cos(-2t) = 2 + 4\cos(2t)$

↑ Par

$x(t) = 4\sin(3t)\cos(2t) \quad x(-t) = -4\sin(3t)\cos(2t)$

↑ Ímpar

⑥ $x[n] = 2n\,(\underbrace{u[n-1] - u[n-3]}_{\substack{\text{Valor 1} \\ \text{quando } n=1,\ n=2}} + \underbrace{\delta[n-4]}_{\substack{\text{Valor 1} \\ \text{quando } n=4}})$

$$E = \sum_{n=-\infty}^{+\infty} |x[n]|^2 = \sum_{n=1}^{4} |x[n]|^2 = 2^2 + 4^2 + 8^2 = 84\ J$$

⑦ $x(t) = t^2 - 4$ $\qquad [-4, -2, 0, 2, 4]$

$$E = \int_{-4}^{4} |t^2-4|^2 \approx \frac{2}{3}\Big[|x(-4)|^2 + |x(4)|^2 +$$

$$+ 2\left(|x(0)|^2\right) + 4\left(|x(-2)|^2 + |x(2)|^2\right)\Big] =$$

$$= \frac{2}{3}\left[144 + 144 + 32\right] = \frac{640}{3}\ J$$

$$E \approx \frac{640}{3}\ J$$

⑧ $x[n] = 2n\,(u[n+1] - u[n-6])$

$y[n] = x[an-b] = x[3n+2] = 2(3n+2)\left[u[3n+3] - u[3n-4]\right]$

$= (6n+4)\left[u[3n+3] - u[3n-4]\right]$

⑨

$y[n] = (n+2)x[n-1] + 2x[n-3] \rightarrow$ Linear

$T\{x_1[n]\} = (n+2)x_1[n-1] + 2x_1[n-3]$

$T\{x_2[n]\} = (n+2)x_2[n-1] + 2x_2[n-3]$

$y_c[n] = (n+2)\left[a x_1[n-1] + b x_2[n-1]\right] + 2\left[a x_1[n-3] + b x_2[n-3]\right]$

$=$, Logo linear

$y_{2c}[n] = a(n+2)x_1[n-1] + 2a x_1[n-3] + b(n+2)x_2[n-1]$
$+ b2x_2[n-3]$

$= (n+2)\left[a x_1[n-1] + b x_2[n-1]\right] + 2\left[a x_1[n-3] + b x_2[n-3]\right]$

$(\ldots)$

$y[n] = 2x[n-1] - 3x[n+4] \rightarrow$ Linear

$T\{x_1[n]\} = 2x_1[n-1] - 3x_1[n+4]$

$T\{x_2[n]\} = 2x_2[n-1] - 3x_2[n+4]$

$y_c[n] = 2\left[a x_1[n-1] + b x_2[n-1]\right]$
$- 3\left[a x_1[n+4] + b x_2[n+4]\right]$

$y_{c_2}[n] = a\left[2x_1[n-1] - 3x_1[n+4]\right] + b\left[2x_2[n-1] - 3x_2[n+4]\right]$

$= 2\left[a x_1[n-1] - b x_2[n-1]\right] - 3$
$\left[x_1[n+4] + x_2[n+4]\right]$

$y[n] = 2(n+1)x[n-1]\,x[n-4] \rightarrow$ Não Linear

$y_1[n] = 2(n+1)\,x_1[n-1]\,x_1[n-4]$

$y_2[n] = 2(n+1)\,x_2[n-1]\,x_2[n-4]$

$y_c[n] = 2(n+1)\left[a x_1[n-1] + b x_2[n-1]\right]\left[a x_1[n-4] + b x_2[n-4]\right]$

$y_{c_2}[n] = 2a(n+1)\,x_1[n-1]\,x_1[n-4] + 2b(n+1)\,x_2[n-1]\,x_2[n-4]$

Resposta: a) Linear, Variante no tempo, causal

b) Linear, Não variante no tempo, não causal

c) Não linear, Variante no tempo, Causal

(10) $y[n] = 3\delta[n-1] - \delta[n-2] + 2\delta[n-3]$

$y[3] = 2$

(11) $\sum_{k=0}^{2} x[k]\,h[2-k] = x[0]h[2] + x[1]h[1] + \cancel{x[2]h[0]}$

$= 1 \times (-2) + 3 \times 3$

$= 9 - 2 = 7$

(12)

$$G(z) = \frac{-0,3z^{-3}+1,9z^{-4}}{(1-0,5z^{-1})(1+0,6z^{-1})} =$$

$$= \frac{-0,3z^{-3}+1,9z^{-4}}{1+0,6z^{-1}-0,5z^{-1}-0,3z^{-2}} = \frac{-0,3z^{-3}+1,9z^{-4}}{1+0,1z^{-1}-0,3z^{-2}} \cdot \frac{z^4}{z^4}$$

$$= \frac{-0,3z+1,9}{z^4+0,1z^3-0,3z^2}$$

Zeros:
$z = 19/3$

Pólos

$z^2(z^2+0,1z-0,3)=0$

$\rightarrow z=0$ duplo $\quad z = \frac{-0,1 \pm \sqrt{0,01+1,2}}{2}$

$z = \frac{-0,1+1,1}{2} \quad z = \frac{-0,1-1,1}{2}$

$= 0,5 \vee -0,6$

Estável //

1 Zero 4 Pólos //

0,35 //

$$G(1) = \frac{-0,3+1,9}{(1-0,5)(1+0,6)} = \frac{1,6}{0,8} = 2 \;//$$

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(13) $\quad G(z) = \frac{0,4z^{-3}}{1-0,8z^{-1}} = \frac{0,4}{1-0,8z^{-1}} \times z^{-3} = H(z)$ | c.i. nulas

z^{-1}

$g[z] = 0,4 \times 0,8^{n-3}\, u[n-3] = h[z]$

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(14) $y[n] = 0,5\,x[n-1] + 0,3\,x[n-3] + 1,1\,y[n-1] - 0,3\,y[n-2]$

$x[n] = 5\,u[n-2] - 2\,\delta[n-5]$

$\mathcal{Z}$

$$Y(z) = 0,5\,z^{-1}X(z) + 0,3\,z^{-3}X(z) + 1,1\,z^{-1}Y(z) - 0,3\,z^{-2}Y(z)$$

$$\Rightarrow Y(z)\left[1 - 1,1\,z^{-1} + 0,3\,z^{-2}\right] = X(z)\left[0,5\,z^{-1} + 0,3\,z^{-3}\right]$$

$$\Rightarrow \frac{Y(z)}{X(z)} = \frac{0,5\,z^{-1} + 0,3\,z^{-3}}{1 - 1,1\,z^{-1} + 0,3\,z^{-2}} = G(z) = H(z)\Big|_{\text{ci nulas}}$$

$$X(z) = \frac{5\,z^{-2}}{1 - z^{-1}} - 2\,z^{-5}$$

$$Y(z) = H(z)\,X(z) = \left[\frac{0,5\,z^{-1} + 0,3\,z^{-3}}{1 - 1,1\,z^{-1} - 0,3\,z^{-2}}\right]\left[\frac{5\,z^{-2}}{1 - z^{-1}} - 2\,z^{-5}\right]$$

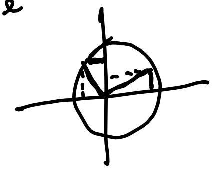
$$\lim_{n\to\infty} y[n] = \lim_{z\to 1}\,(1 - z^{-1})\,Y(z) =$$

$$= \lim_{z\to 1}\left[\frac{5\,z^{-2}}{\cancel{(1 - z^{-1})}} \times \cancel{(1 - z^{-1})} \times \frac{0,5\,z^{-1} + 0,3\,z^{-3}}{1 - 1,1\,z^{-1} + 0,3\,z^{-2}}\right]$$

$$= 5 \times 4 = 20$$

15 - $\Omega = 3$ rad $\quad H(3) = 3j = 3e^{i\pi/2}$

$x[n] = 2\sin[3n] \quad |H(3)| = 3$

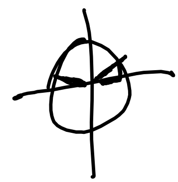


$x[n] = e^{i\Omega n}$

$$x[n] = \underset{C_i}{2}\cos[\underset{\Omega_i}{3}n + \underset{\theta_i}{\pi/2}]$$

$$y[n] = 2|H(3)|\cos(3n - \pi/2 + \measuredangle H(3))$$

$$= 6\cos(3n)$$



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$w_0 = 6$

$$4(\sin(3t+1))^2 = 4\left[\frac{1-\cos(6t+2)}{2}\right] =$$

$$= 2 - 2\cos(6t+2) \qquad m=0 \text{ \&\& } m=1$$

$w_0 = 5$

$$x(t) = 2\cos(5t) + \sin(5t-1) =$$

$$= 2\cos(5t) + \cos(5t-1-\pi/2)$$

$m = 1$

$$x(t) = 4\sin(6t)\cos(9t-6) =$$

$$= 4\cdot\frac{1}{2}[\cos(6t-9t+6) - \cos(6t+9t-6)]$$

$$= 2[\cos(6-3t) - \cos(15t-6)]$$

$$= 2\cos(6-3t) - 2\cos(15t-6)$$

$w_0 = 3$

$m = 1 \wedge m = 5$

(H)

$w_0 = 5$

$$x(t) = 1 + \cos(5t-1)$$

$m=0 \text{ \&\& } m=1$

R: C
A
H
C

(17)

$C_3 = 2|c_3| \quad \theta_3 = -\angle c_{-3}$

$C_4 = 2|C_4|$

$C_0 = |C_0|$

F
F
V
V

(18)

$5w_0 = 100\pi \Rightarrow w_0 = \frac{100\pi}{5} = 20\pi$ Rad/s

$w_2 = 2w_0 = 40\pi$ Rad/s $\qquad w = 2\pi f \Rightarrow f = \frac{w}{2\pi} = 20$ Hz

$w_5 = 100\pi \quad w_5 = 2\pi f_5 \Rightarrow f_5 = \frac{100\pi}{2\pi} = 50$ Hz

(19) Verdadeiro