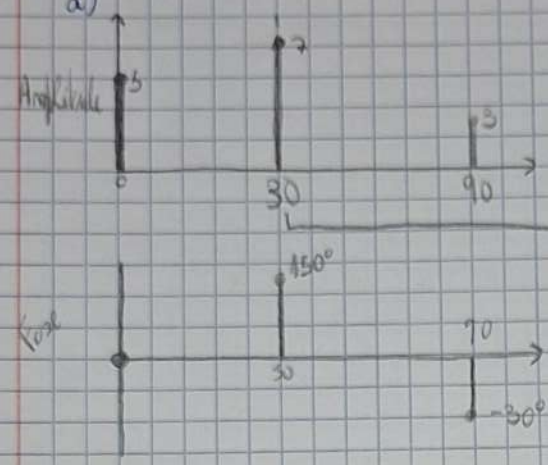
→ Fundamentos e Comunicação de dados - Ficha 5

1-

a)

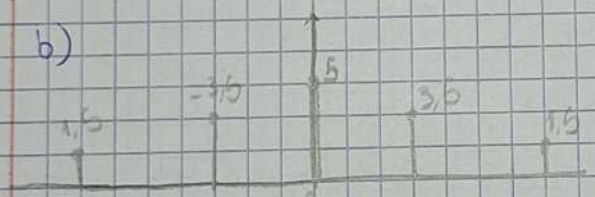


$x(t) = c_0 + c_1 (\cos(2\pi f_0 t + 150)) + c_3 (\cos(2\pi f_0 t - 30))$

$= 5 + 7(\cos(2\pi \times 30t + 150)) + 3\cos(2\pi \times 90t - 30$

$= 5 + 7\cos(60\pi t + 150) + 3\cos(180\pi t - 30$

b)



$x(t) = c_0 + \sum_{m=1}^{+\infty} c_m (\cos(2\pi m f_0 t + \theta_m))$

unilateral $\uparrow$ $c_0 = c'_0$ → bilateral

$c_m = 2c'_m$ ↗

2-

A1 - V

$x(t) = 0,7 + 0,6\cos(400\pi t) + 0,5\cos(800\pi t) + 0,4\cos(1600\pi t) + 0,3\cos(2400\pi t)$

$+ 0,2(2800\pi t)$

B2 - F

$T_0 = 5\text{ms}? = 5 \times 10^{-3}\text{s} \Rightarrow f_0 = \frac{1}{T_0} = \frac{1}{5 \times 10^{-3}} = 200\text{ Hz}$

$400\pi t = 2\pi f_0 t \Rightarrow f_0 = \frac{400}{2} = 200\text{ Hz}$

C3 - F

D4 - F

Período $= \frac{1}{f_0} = 5 \times 10^{-3}$ s

3 -

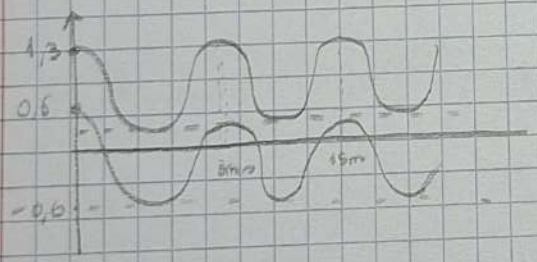
a) foto

b) • filtro passa baixo (só deixa passar frequências abaixo de x)

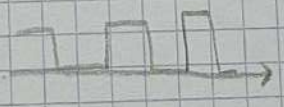
$F_{PB}(F, x(t)) = \sum_{n=0}^{+\infty} [c_n \cos(2\pi n f_0 t + \delta_n)]$

$F_{PB}(250, x(t)) = 0,7 + 0,6 \cos(400 \pi t)$

$\rightarrow f_0 = 200$ Hz



4 - $V(t) = A f_0 \frac{\sin(\pi n f_0 \gamma)}{\pi n f_0}$



$C_0 = \frac{A}{2}$, $n = 0$

$y(t) = 2V(t) - A = 2 \times [C_0 + \sum_{n=1}^{+\infty} C_n \times \cos(2\pi n f_0 t + \delta_n)] - A$

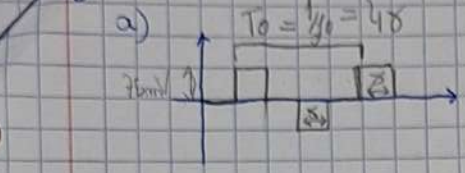
$= \frac{2A}{2} + [\sum_{n=1}^{+\infty} 2 \times C_n \cos(2\pi n f_0 t + \delta_n)] - A$

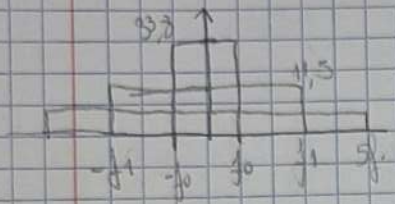
$= A + [\sum_{n=1}^{+\infty} 2A \frac{\sin(\pi n f_0 \gamma)}{\pi n} \cos(2\pi n f_0 t) + \theta] - A$

$= C_n' = \frac{2A \sin(\pi n f_0 \gamma)}{\pi n}$, $T_0 = 2\gamma \Leftrightarrow \frac{1}{f_0} = 2\gamma \Leftrightarrow \frac{1}{2} = \frac{1}{f} \gamma$

6-

a) $T_0 = \frac{1}{f_0} = 4\gamma$





$$c_n = \begin{cases} \frac{A\sqrt{2}}{2\pi n}\left[\cos(\pi n) - 1\right] & n \neq 0 \\ 0 & n = 0 \end{cases}$$

b) $S = \int_{T_0} |V(t)|^2 \, dt$

$= \frac{\text{Área}\ (V(t)^2)}{T_0} = \frac{0,0225^2 \times 23}{4\gamma} = 0,0023\ \text{watt}$

90% de 0,0028 = 0,00252

- Teo T. Parseval

$S_{cn} = \sum_{n=-\infty}^{+\infty} c_n^{+2} \Rightarrow \sum_{n=0}^{n=+\infty} 2|c_n|^2$

$S_{0,1} = c_0^2 + 2c_1^2 = 0 + 2(37,8 \times 10^{-3})^2 = 0,0023\ \text{watio}$

$< 0,00252$

$S_{0,1,2,3} = c_0^2 + 2c_1^2 + 2c_2^2 + 2c_3^2 +$

$= 0 + 0,0023 + 0 + (11,3 \times 10^{-3})^2 = 0,00254 > 0,00252\ \text{watio}$

$B = [f_i, f_n] = [f_0, Bf_0] = 3f_0 - f_0 = 2 \times 500 \times 10^3$

$= 10^6 = 1\,MHz$

$T_0 = 4\gamma$ dato/ $T_0 = 4 \times \frac{1}{2 \times 10^6} \Rightarrow f_0 = \frac{1}{T_0} = \frac{1}{4} \times 2 \times 10^6 = 0,5 \times 10^6$

$= 500\,KHz$

7-

A1- F B2- V C3- F D4- V

$100\pi b = 2\pi f_0 b \Rightarrow f_0 = 50 Hz$

$x(t) = 0,6\cos(0\pi t) + \overbrace{0,4}^{C_1}\cos(\overbrace{100\pi t}^{f}) + 0,3\cos(400\pi t) + 0,2\cos(800\pi t)$

$+ 0,1\cos(1600\pi t) + 0,05\cos(3200\pi t) + \dots$

- $S_t = 400\ mW$
- $C_0 = 0,5 \quad C_1 = 0,4 \quad C_2 = 0$
- $S_{cn} = C_0^2 + \sum_{n=1}^{+\infty} 2C_n^{1/2}$
  - $S_0 = 0,5^2 = 0,25\ watt < 0,36\ watt$
  - $S_{0,1} = C_0^2 + 2C_{1/2}^{1/2} = 0,25 + 2\cdot(0,2)^2 = 0,33 < 0,36$
  - $S_{0,1,2,3,4} = 0,33 + 2C_4^{1/2} = 0,33 + 2\cdot(0,15)^2 = 0,375 > 0,36$

$B = [0,4] - [0] = [0,200] = 200\ Hz$