GABARITO 2ª Chamada 2016.1 (PCOM)

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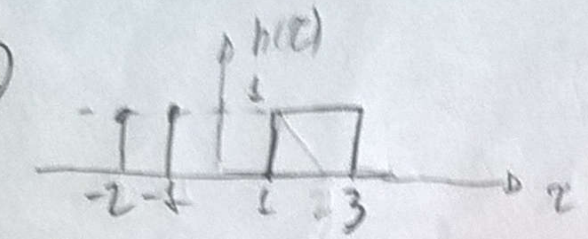
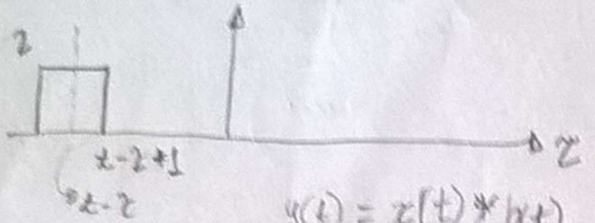
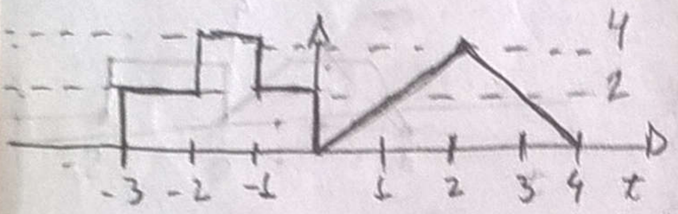




$y(t) = x(t) * h(t)$



I1: $t < -3$ $y(t) = 0$

I2: $-3 \le t \le -2$

$$y(t) = \int_{-3}^{t+1} 2\delta(\tau)\, d\tau = 2$$

I3: $-2 \le t \le -1$

$$y(t) = \int_{2}^{t+1} 2.2\delta(\tau)\, d\tau = 4$$

I4: $-1 \le t \le 0$

$$y(t) = \int_{-1}^{t+1} 2.\delta(\tau)\, d\tau = 2$$

I5: $0 \le t \le 2$

$$y(t) = \int_{1}^{t+1} 2\, d\tau = 2\tau\Big|_{1}^{t+1} = 2t$$

I6: $2 \le t \le 4$

$$y(t) = \int_{t-1}^{3} 2\, d\tau = 2\tau\Big|_{t-1}^{3} = 6 - 2(t-1) = 8 - 2t$$

I7: $t \geq 4$ $y(t) = 0$

② $x(t) = 1 - \cos^2(w_0 t) + \cos^2(w_0 t) \cdot \cos^2(w_0 t)$

$= 1 - \left(\frac{1}{2} + \frac{1}{2}\cos(2w_0 t)\right) + \left(\frac{1}{2} + \frac{1}{2}\cos(2w_0 t)\right)^2$

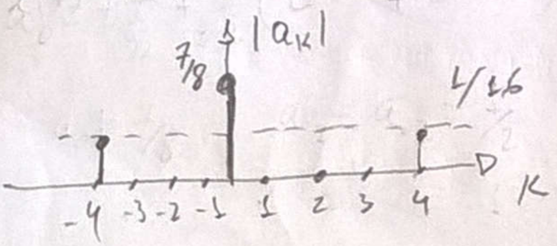
$= 1 - \frac{1}{2} - \frac{1}{2}\cos(2w_0 t) + \frac{1}{4} + \frac{1}{2}\cos(2w_0 t) + \frac{1}{4}\cos^2(2w_0 t)$

$= \frac{3}{4} + \frac{1}{4}\cos^2(2w_0 t) = \frac{3}{4} + \frac{1}{4}\left(\frac{1}{2} + \frac{1}{2}\cos(4w_0 t)\right)$

$x(t) = \frac{7}{8} + \frac{1}{8}\cos(4w_0 t) = \frac{7}{8}e^{-j0} + \frac{1}{16}\left(e^{j4w_0 t} + e^{-j4w_0 t}\right)$

$a_0 = 7/8, \quad a_4 = a_{-4} = 1/16, \quad a_k = 0$

$\boxed{\text{fase é zero}}$



③ $X(w) = \frac{1}{2+jw} \cdot e^{-2jw} * \frac{1}{2}\left(\delta(w-w_0) + \delta(w+w_0)\right) = \frac{e^{-j(w-w_0)}}{2(4+j(w-w_0))} + \frac{e^{-j(w+w_0)}}{2(4+j(w+w_0))}$

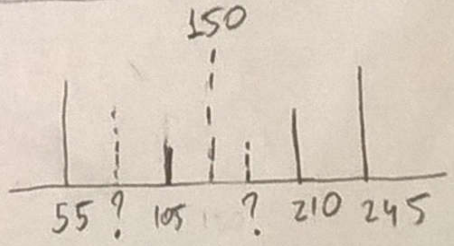
$\frac{d}{dt}x(t) \overset{\mathcal{F}}{\longleftrightarrow} jw X(w)$

$\frac{d}{dt}x(t) \overset{\mathcal{F}}{\longleftrightarrow} \frac{jw}{2}\left(\frac{e^{-j(w-w_0)}}{4+j(w-w_0)} + \frac{e^{-j(w+w_0)}}{4+j(w+w_0)}\right)$

$e^{-at}u(t) \overset{\mathcal{F}}{\longleftrightarrow} \frac{1}{a+jw}$

$e^{-4(t-1)} \overset{\mathcal{F}}{\longleftrightarrow} \frac{1}{4+jw} \cdot e^{-jw}$

$\cos(2t) \overset{\mathcal{F}}{\longleftrightarrow} \frac{1}{2}\left(\delta(w-w_0) + \delta(w+w_0)\right)$



④ As componentes são: 55 kHz (5), 105 kHz (1), 210 kHz (3), 245 kHz (5)

Para as componentes de amplitude 5: $(245+55)/2 = 150$

$w_c = 150 \Rightarrow c(t) = 10\cos(300\pi \cdot 10^3 t)$

$m(t) = \frac{2}{10}\cos(2\pi \cdot 45 \cdot 10^3 t) + \frac{6}{10}\cos(2\pi \cdot 60 \cdot 10^3 t) + \frac{10}{10}\cos(2\pi \cdot 95 \cdot 10^3 t)$

$\varphi(t) = m(t) \cdot 10\cos(2\pi \cdot 150 \cdot 10^3 t)$

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5) $\varphi_{PM}(t) = A_c \cos(\omega_c t + k_p m(t))$

$k_p m(t) = 2\pi m(t) + 2 \operatorname{sen}(50\pi t)$

$$\boxed{m(t) = \frac{1}{k_p}(2\pi m(t) + 2 \operatorname{sen}(50\pi t))}$$

$m'(t) = \frac{1}{k_p}(2\pi m'(t) + 100\pi \cos(50\pi t))$

$m'_p = \frac{1}{k_p}(2\pi . 80 + 100\pi) = \frac{260\pi}{k_p}$

$$\boxed{\Delta f = \frac{k_p . m'_p}{2\pi} = \frac{260\pi}{2\pi} = 130}$$

$$\boxed{\beta = \frac{\Delta f}{B} = \frac{130}{20}}$$

$$\boxed{B_{PM} = 2(130 + 600) = 1430 Hz}$$

O sinal m(t) é uma onda quadrada que tem infinitas componentes frequenciais.

Como é periódico

$a_k = \frac{\operatorname{sen}(\pi k/2)}{k\pi}$.

Vamos considerar apenas o terceiro harmônico, onde se tem uma energia significativa.

$f_0 = \frac{1}{T} = \frac{1}{5ms} = 200 Hz$

3º harmônico é 600 Hz

$f_{max} = 600 Hz$

A largura de banda de m(t) é B = 600 Hz.