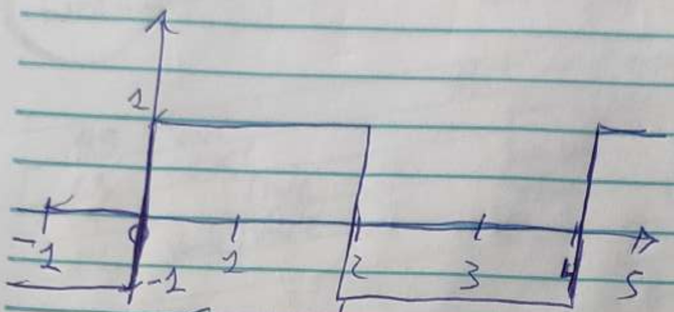
(1) Para a onda quadrada, determine a amplitude e fase da 1ª harmônica, série trigonométrica de Fourier

$T = 4s$

$\Rightarrow \omega = 2\pi/4 = \pi/2$



Série Trigonométrica: $x(t) = A_0 + \sum_{k=1}^{\infty} A_k \cdot \cos(k\omega_0 t + \phi_k)$

$A_0 = a_0 \quad A_k = 2\cdot|a_k| \quad \phi_k = \angle a_k$

$\Rightarrow a_k = \frac{1}{T}\int_{-T/2}^{T/2} x(t)\cdot e^{-jk\omega_0 t}\, dt = \frac{1}{4}\cdot\int_{-2}^{2} x(t)\cdot e^{-jk\frac{\pi}{2}t}\, dt$

$\Rightarrow \frac{1}{4}\cdot\left[\int_{-2}^{0} -e^{-jk\frac{\pi}{2}t}\,dt + \int_{0}^{2} e^{-jk\frac{\pi}{2}t}\,dt\right]$

$\Rightarrow \frac{1}{4}\cdot\left[\frac{2}{-jk\pi}\cdot\left(-e^{-jk\frac{\pi}{2}t}\Big|_{-2}^{0}\right) + \frac{2}{-jk\pi}\cdot\left(e^{-jk\frac{\pi}{2}t}\Big|_{0}^{2}\right)\right]$

$\Rightarrow \frac{1}{-2jk\pi}\cdot\left[e^{jk\pi} + e^{-jk\pi} - 2\right] \Rightarrow \frac{\frac{e^{jk\pi}+e^{-jk\pi}}{2j}}{k\pi} = sinc(k\pi)$

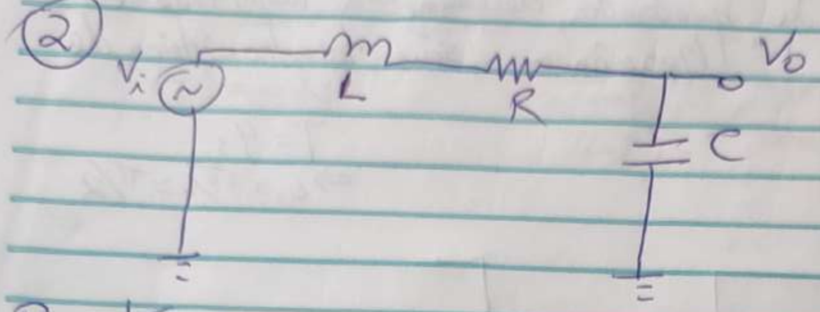
$\Rightarrow a_k = -sinc(k\pi) - j\frac{1}{k\pi} = -sinc(k\pi) - \frac{1}{k\pi}e^{j\pi/2}$

amplitude $a_1 = \frac{sen(\pi)}{\pi} + \frac{1}{\pi} = 2/\pi$ fase $= -\pi/2$

↓

Primeira harmônica

2



$T = 4\,s$

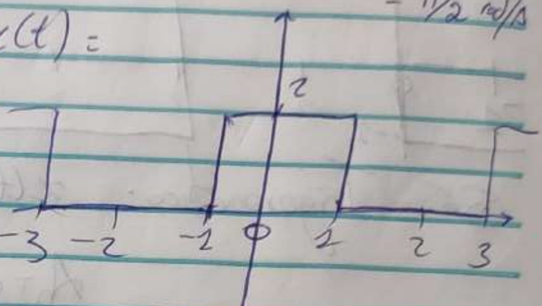
$\omega = \frac{2\pi}{T} = \pi/2\ rad/s$

$R = 1/\sqrt{2}\ \Omega$

$L = \sqrt{2}/\pi\ H$

$C = \sqrt{2}/\pi\ F$

$x(t) =$



$Z_L = j\omega L = j\frac{\pi}{2}\cdot\frac{\sqrt{2}}{\pi} = j\frac{\sqrt{2}}{2} = \frac{\sqrt{2}}{2}\cdot e^{j\pi/2}$

$Z_C = \frac{1}{j\omega C} = \frac{1}{j\frac{\pi}{2}\cdot\frac{\sqrt{2}}{\pi}} = -j\frac{2}{\sqrt{2}} = \frac{2}{\sqrt{2}}\cdot e^{-j\pi/2}$

$H(j\omega) = \frac{V_o(\omega)}{V_i(\omega)} = \frac{Z_C}{Z_C + Z_L + R} = \frac{-j/\omega C}{-j/\omega C + j\omega L + R} = \frac{-j}{-j + j\omega^2 LC + R\omega C}$

$H(0) = 1$ → nível DC

$Y(0) = X(0)\cdot H(0) = 1$

$Y(j\omega) = X(j\omega)\cdot H(j\omega)$

$\Rightarrow H(j\pi/2) = \frac{-j}{-j + j\,0{,}5^2\cdot\left(\frac{\sqrt{2}}{\pi}\right)^2 + \frac{1}{\sqrt{2}}} = \frac{-j}{-j + j\frac{1}{2\pi^2} + \frac{1}{\sqrt{2}}\left(\frac{\sqrt{2}}{\pi}\right)^2}$

$\frac{-j}{-j + j\frac{1}{2} + \cancel{\ }} \Rightarrow |H(j\frac{\pi}{2})| = \frac{1}{\sqrt{2}}$

$\angle H(j\pi/2) = -45^\circ = -\pi/4\ rad$

$\Rightarrow y_1(t) = c_K\cdot\cos(\omega t + \phi_K) = \frac{4}{\sqrt{2}\pi}\cdot\cos\left(\frac{\pi}{2}t + \pi/4\right)$

$c_K = \frac{1}{\sqrt{2}}\cdot a_K$ → coeficiente série fourier onda quadrada sinal $x(t)$