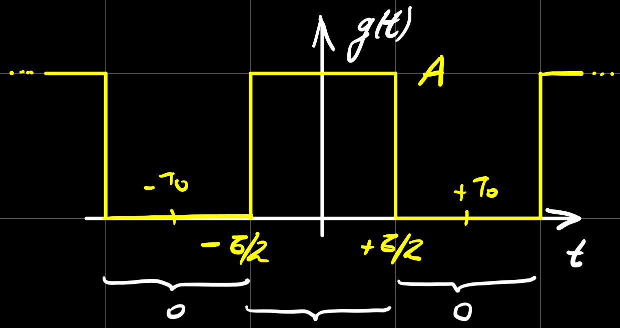
0. Descrição



τ ... largura do pulso

A ... amplitude

T_0 ... período

$$D_n = \frac{1}{T_0}\int_{T_0} g(t)\cdot \underbrace{e^{-jn\omega_0 t}}\, dt$$

BASE → FIXA → ω_0

1. $$D_n = \frac{1}{T_0}\cdot \int_{-\tau/2}^{+\tau/2} \underset{g(t)}{A}\cdot e^{-jn\omega_0 t}\, dt \qquad \underbrace{-jn\omega_0}_{a} t \to x$$

$$D_n = \frac{1}{T_0}\, A \cdot \left.\frac{e^{-jn\omega_0 t}}{-jn\omega_0}\right|_{-\tau/2}^{+\tau/2} = \underbrace{\frac{A}{T_0}}\cdot \frac{\overbrace{e^{-jn\omega_0\tau/2} - e^{+jn\omega_0\tau/2}}^{-2j\,\text{sen}(n\omega_0\tau/2)}}{-jn\omega_0}$$

euler:

$$e^{-jn\omega_0\tau/2} = \cos(n\omega_0\tau/2) - j\,\text{sen}(n\omega_0\tau/2)$$

$$-\; e^{+jn\omega_0\tau/2} = \cos(n\omega_0\tau/2) + j\,\text{sen}(n\omega_0\tau/2)$$

$$-2j\,\text{sen}(n\omega_0\tau/2)$$

$$D_n = \frac{A}{T_0}\cdot\frac{\cancel{-}2\cancel{j}\,\text{sen}(n\omega_0\tau/2)}{\cancel{-j}\,n\omega_0} = \frac{A}{T_0}\cdot\frac{2\cdot \text{sen}(n\omega_0\tau/2)}{n\omega_0}$$

$$\int e^{ax}\,dx = \frac{1}{a}\cdot e^{ax}$$

$$D_n = \frac{A}{T_0} \cdot \frac{2 \cdot \operatorname{sen}(n\omega_0 \tau/2)}{n\omega_0} = \frac{2A}{T_0} \cdot \underbrace{\frac{\operatorname{sen}(n\omega_0 \overset{x}{\tau/2})}{n\omega_0 \tau/2}} \cdot \tau/2$$

$$D_0 = \frac{2A}{T_0} \cdot \frac{\operatorname{sen}(0 \cdot \omega_0 \tau/2)}{0 \cdot \omega_0} = \frac{2A}{T_0} \underbrace{\frac{\operatorname{sen} 0}{0}} = \frac{0}{0} \,!$$

$$! \quad \underbrace{\lim_{x \to 0} \frac{\operatorname{sen}(x)}{x}}_{=1} = \lim_{x \to 0} \frac{\cos(x)}{1} = 1$$

$$D_n = \frac{A\tau}{T_0} \cdot \frac{\operatorname{sen}(n\omega_0 \tau/2)}{n\omega_0 \tau/2}$$

$$D_0 = \frac{A\tau}{T_0} \underbrace{\frac{\operatorname{sen}(0)}{0}}_{\lim = 1} = \frac{A\tau}{T_0}$$

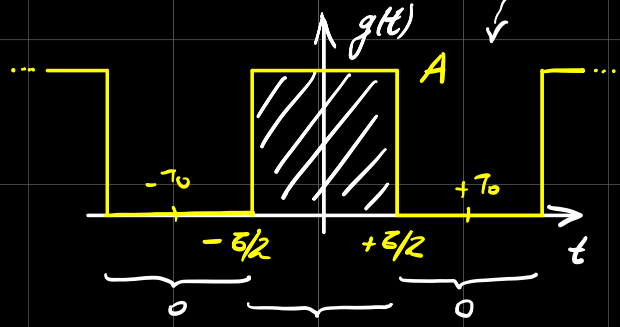
Qual o significado de D_0? $n=0$

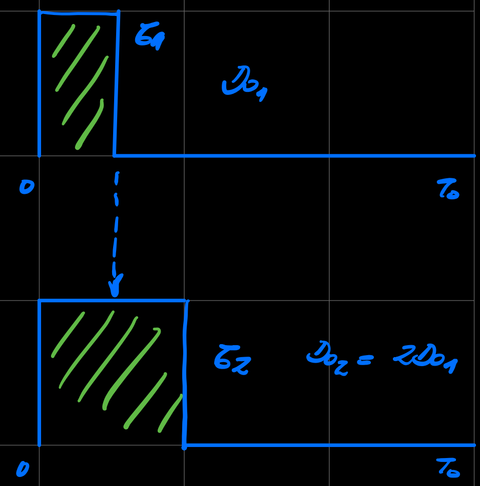
Base $e^{-jn\omega_0 t} \longrightarrow \underbrace{n\omega_0}_{\text{modificação}}$

$0 \cdot \omega_0 = 0 \therefore f = 0\,\text{Hz}$ de frequência

Nivel medio , $D_0 = \frac{A\tau}{T_0}$

0. Desnível





$$D_n = \frac{A\tau}{T_0} \cdot \frac{\operatorname{sen}(n\omega_0\tau/2)}{n\omega_0\tau/2}$$

$$D_1 = \frac{A\tau}{T_0} \frac{\operatorname{sen}(\omega_0\tau/2)}{\omega_0\tau/2}$$

$$D_{-1} = \frac{A\tau}{T_0} \frac{\operatorname{sen}(-\omega_0\tau/2)}{-\omega_0\tau/2}$$

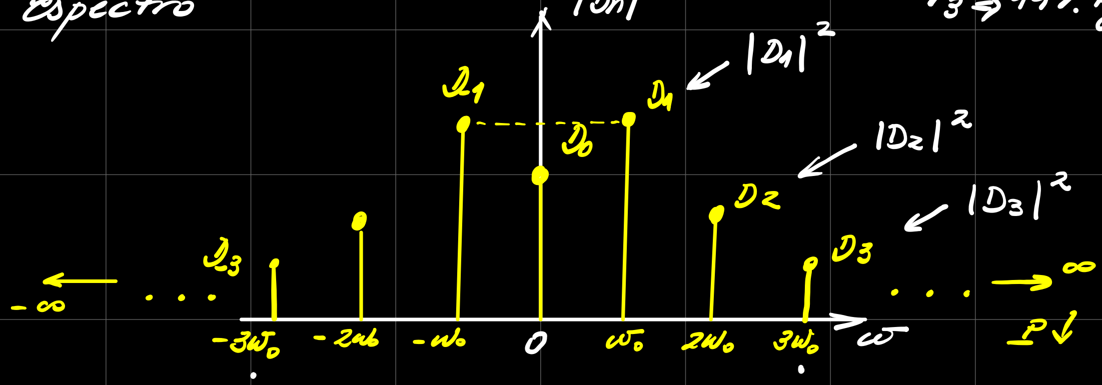
$$g(t) = \sum_{n=-\infty}^{\infty} D_n e^{jn\omega_0 t} =$$

$$\underbrace{D_{-1} e^{-j\omega_0 t} + D_0 + D_{+1} e^{+j\omega_0 t}}$$

$$D_{-2} e^{-2j\omega_0 t} + \quad \dots \quad + D_2 e^{+2j\omega_0 t}$$

Espectro

$P_3 \Rightarrow 99\%\, P_g$



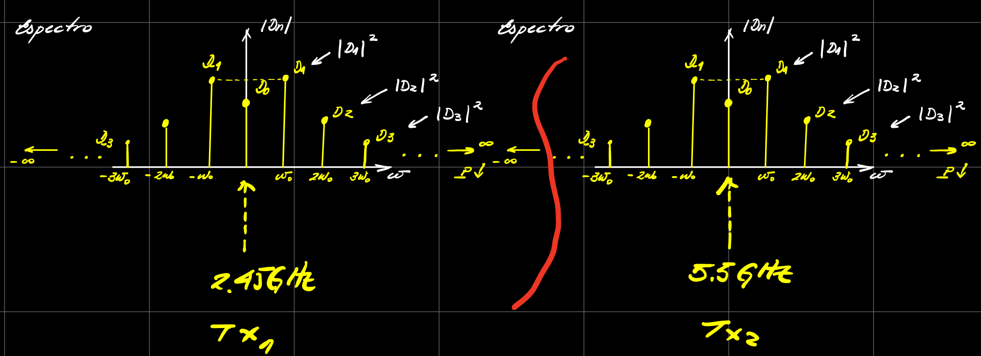
$$\underbrace{B = 6\omega_0}$$

$$D_n = \frac{A\tau}{T_0} \cdot \frac{\sin(n\omega_0\tau/2)}{\underbrace{n\omega_0\tau/2}_{n \to \infty}}$$

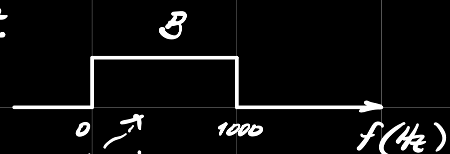
$$D_n \to 0$$

$$P(D_n) = |D_n|^2 \quad \dots \quad e^{jn\omega_0 t}$$

$$\frac{A^2}{2} \quad \dots \quad A\cos(n\omega_0 t)$$



eletro Fourier



espectro

?

Compara espectro com a banda!

$$D_n = \frac{1}{T_0}\int_{T_0} \underbrace{g(t)} e^{-jn\omega_0 t}\, dt$$

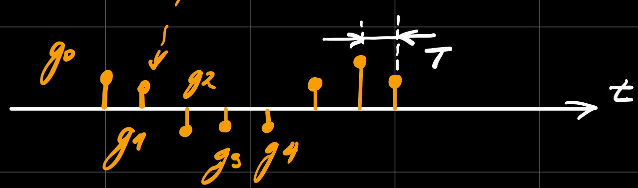
VOZ, ELETRO, MÚSICA, ...

$g(t) = ?$

gravar

.wav

amostras



$$\begin{bmatrix} g_0 \\ g_1 \\ g_2 \\ g_3 \\ \vdots \end{bmatrix}$$

← amostras

$f_s = 44100\ Hz$

amostras

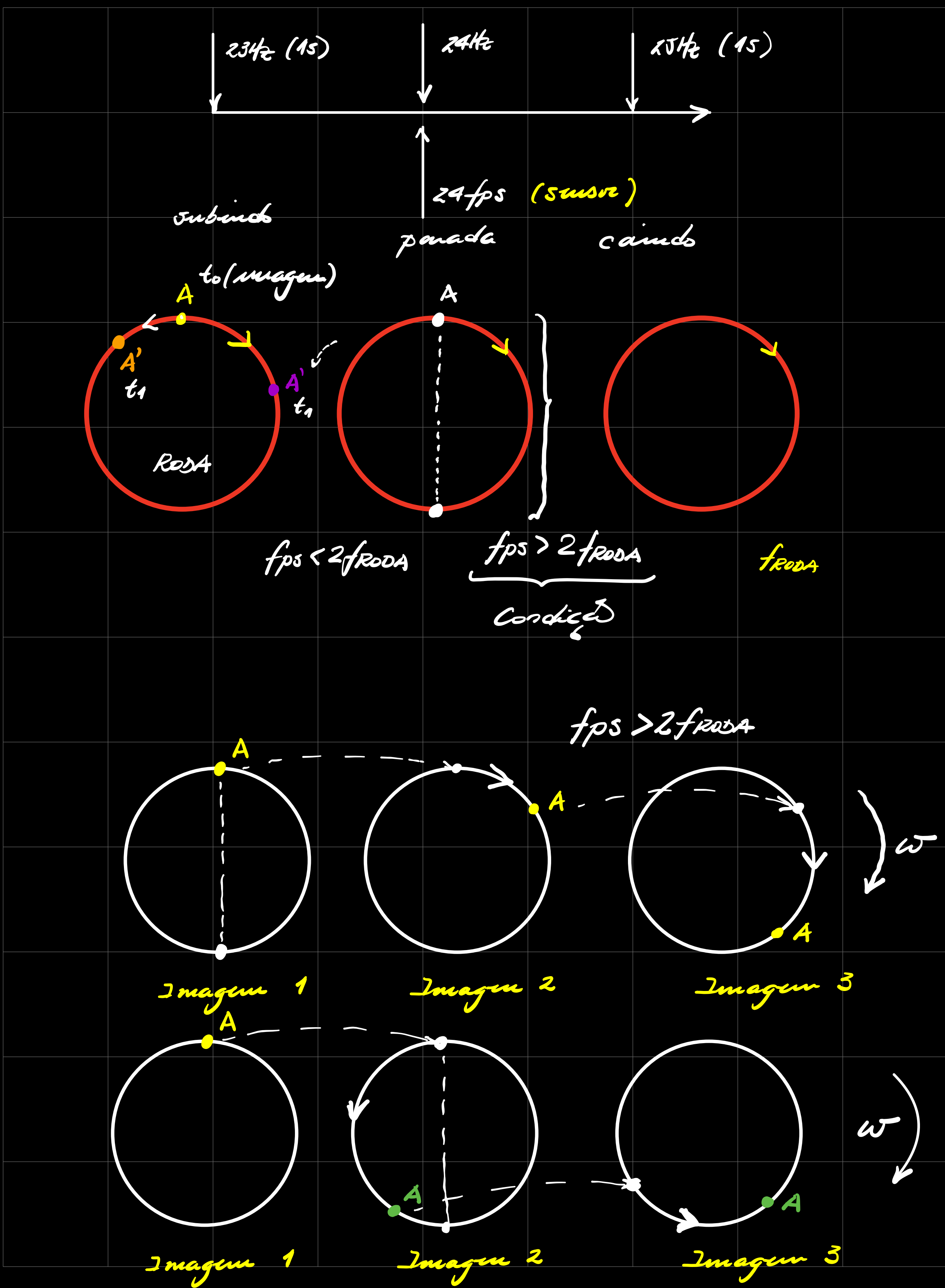
vetor

$$g(t) \longrightarrow g(kT)$$

(·) Teorema da amostragem

Camera 24 fps (24 Hz)

Senoide 24 Hz $\Longrightarrow$ parada



23Hz (1s)
24Hz
25Hz (1s)
24 fps (sensor)
subindo
parada
caindo
t0 (imagem)
A
A'
t1
A'
t1
RODA
A
fps < 2 f_RODA
fps > 2 f_RODA
condição
f_RODA
fps > 2 f_RODA
A
A
A
ω
Imagem 1
Imagem 2
Imagem 3
A
A
A
ω
Imagem 1
Imagem 2
Imagem 3

Teorema da amostragem

$f_s > 2 f_{máx}$

sampling

.wav $\longrightarrow$ $f_s = 44100 Hz$ filtros

$$f_{máx} = \frac{44100 Hz}{2} = \underbrace{22050 Hz}$$

áudio (música) $\longrightarrow$ $\longrightarrow$ 20.000 Hz