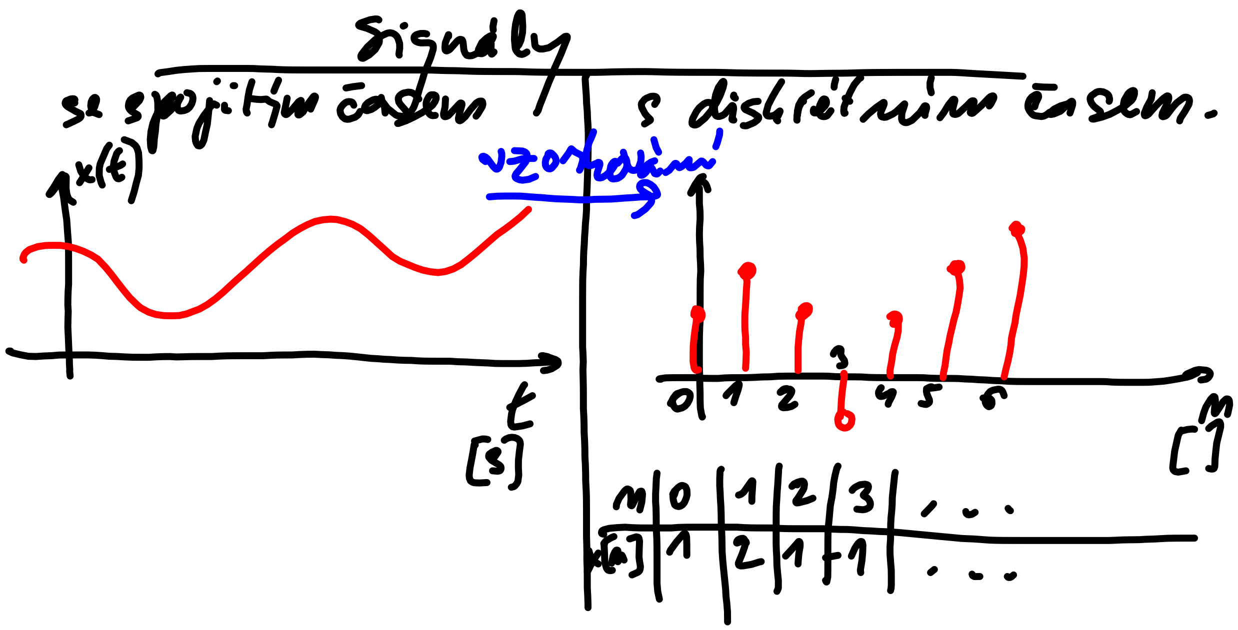
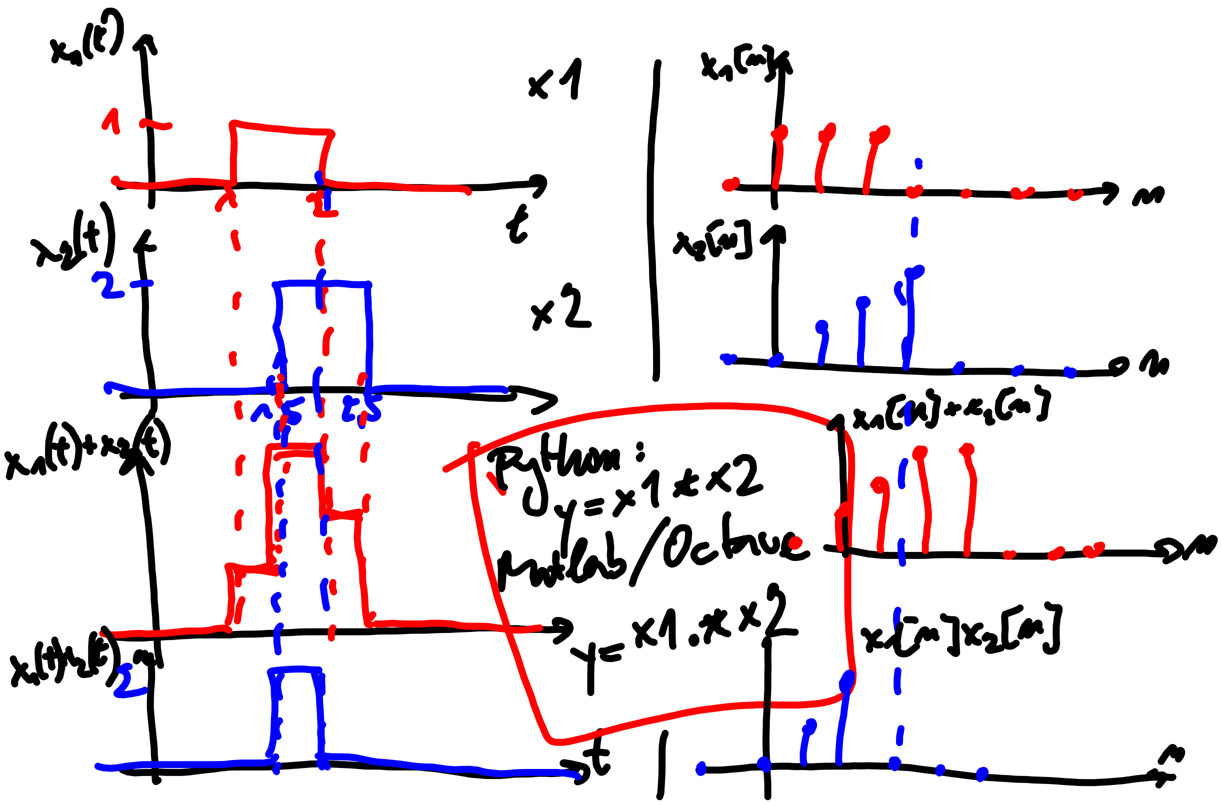
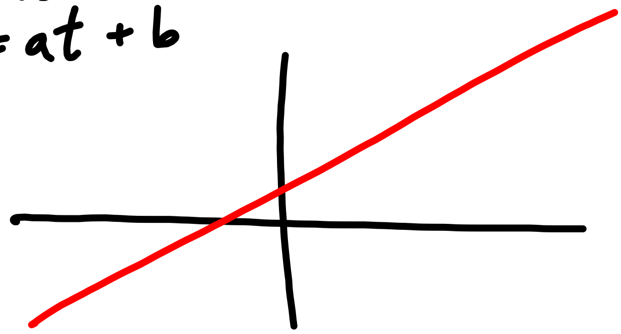

Signály
se spojitým časem
s diskrétním časem.
vzorkování
x(t)
t
[s]
0 1 2 3 4 5 6
n
[ ]
n | 0 | 1 | 2 | 3 | ...
x[n] | 1 | 2 | 1 | -1 | ...


$x_1(t)$
$x_2(t)$
$x_1(t)+x_2(t)$
$x_1(t)x_2(t)$
×1
×2
$x_1[n]$
$x_2[n]$
$x_1[n]+x_2[n]$
$x_1[n]x_2[n]$
Python:
y=x1*x2
Matlab/Octave
y=x1.*x2

Lineární závislost

$x(t) = at + b$



Derivace

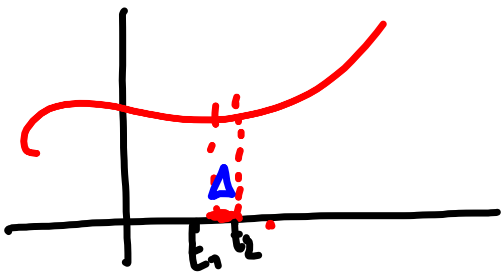
$x(t) = t^2 + 2t + 3$

derivace pro $t=0$ a pro $t=1$

analyticky: $\frac{dx(t)}{dt} = 2t + 2$

pro $t=0$: 2
$t=1$: 4

numericky: $\left.\frac{dx(t)}{dt}\right|_{t_1} = \frac{x(t_2) - x(t_1)}{t_2 - t_1}$



Integrál

$x(t)=t^2+2t+3$

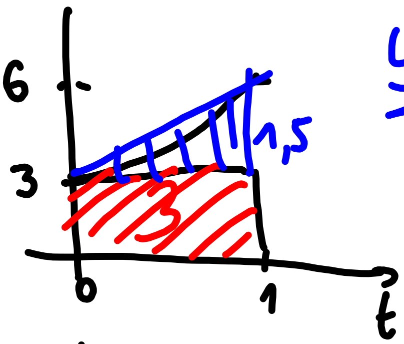
$t_1=0$

$t_2=1$

$$\int_{t_1}^{t_2} x(t)\,dt$$

analyticky: $\left[\frac{t^3}{3}+t^2+3t\right]_0^1=\left(\frac{1}{3}+1+3\right)-\left(0+0+0\right)=\underline{\underline{4{,}33}}$

prasácky:

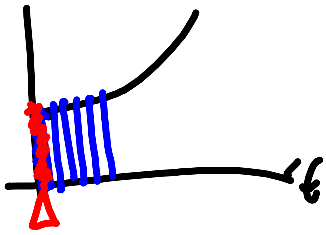


$\underline{\underline{4{,}5}}$

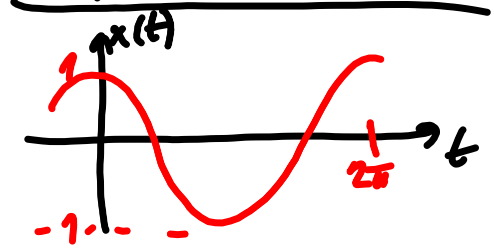
numericky:

$$\sum_{n=0}^{N-1} x\left(t_1+n\underbrace{\frac{t_2-t_1}{N}}_{\Delta}\right)\Delta$$

$=4{,}26$



Cosinusovka



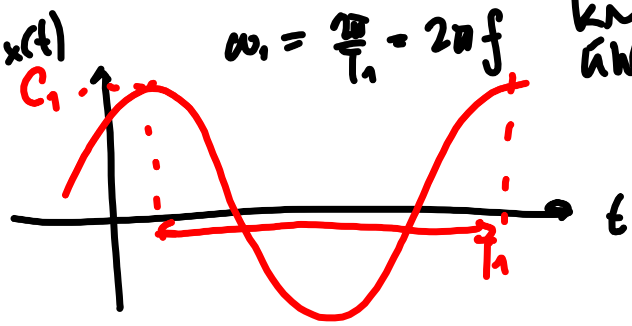
$x(t) = \cos(t)$

$T_1 = \frac{1}{50}$ s

$x(t) = 220 \cos\left(2\pi \frac{t}{T_1}\right)$

$\frac{1}{T_1} = f$ frekvence [Hz]

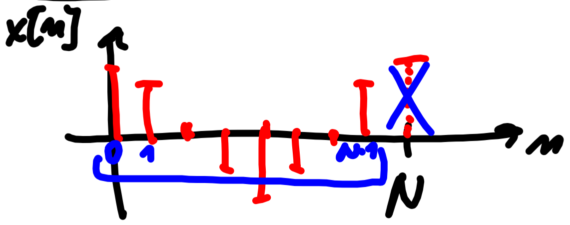
$\omega_1 = \frac{2\pi}{T_1} = 2\pi f$ kruhová / úhlová frekvence / rychlost [rad/s]



$x(t) = C_1 \cos(\omega_1 t + \varphi_1)$

C_1 [cokoliv], ω_1 [rad/s], φ_1 rad

Cos. s disk. časem



~~$x[n] = \cos(n)$~~

$x[n] = \cos\left(2\pi \frac{n}{N}\right)$

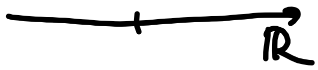
$\frac{1}{N}$ normovaná frekvence [ ]

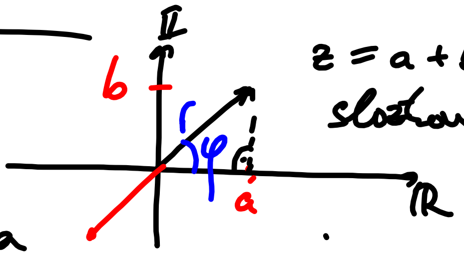
$\frac{2\pi}{N}$ normovaná kruhová frekvence [rad]

$x[n] = C_1 \cos(\omega_1 n + \varphi_1)$

C_1 – cokoliv, ω_1 – rad, φ_1 – rad.

komplexní čísla



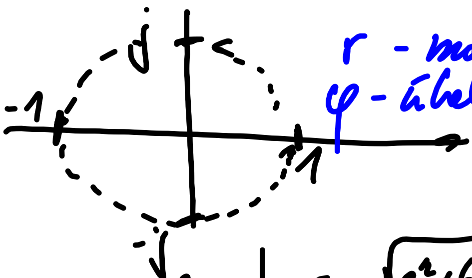


$z = a + bj$

složky $\mathbb{C}$

j komplexní jednotka

$j = \sqrt{-1}$



r - modul (abs. h.)

φ - úhel, argument

1, j, j, j, j

$a = r\cos\varphi$

$b = r\sin\varphi$

$r = \sqrt{a^2+b^2}$

$\varphi = \arctan\left(\frac{b}{a}\right)$!

phi = np.angle(z)

Exponenciální tvar k. č.

$z = re^{j\varphi}$ $\quad z = r\exp(j\varphi)$ $\quad z = r\angle\varphi$

Operace s k. č.

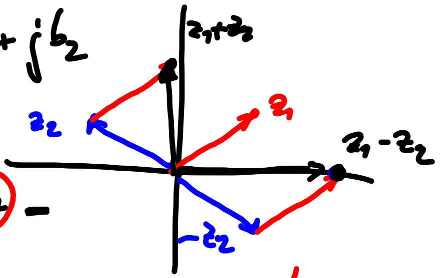
$z_1 = a_1 + jb_1$ $\quad z_2 = a_2 + jb_2$

$z_1 + z_2 = a_1 + a_2 + j(b_1 + b_2)$

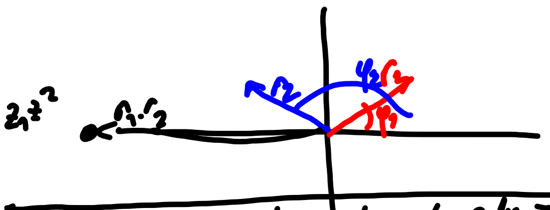
$z_1 - z_2 = a_1 - a_2 + j(b_1 - b_2)$

$z_1 z_2 = r_1 e^{j\varphi_1} \cdot r_2 e^{j\varphi_2} = r_1 r_2 \cdot e^{j\varphi_1} e^{j\varphi_2} =$

$= r_1 r_2 e^{j(\varphi_1+\varphi_2)}$

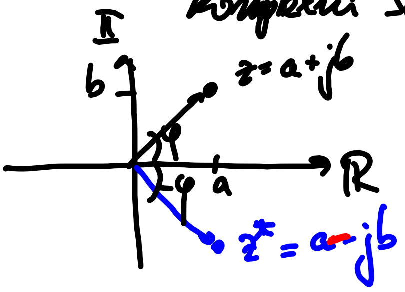


$e^a \cdot e^b = e^{a+b}$



$\frac{z_1}{z_2} = \frac{r_1}{r_2} e^{j(\varphi_1 - \varphi_2)}$

komplexní sdružení



$z = re^{j\varphi}$

$z^* = re^{-j\varphi}$

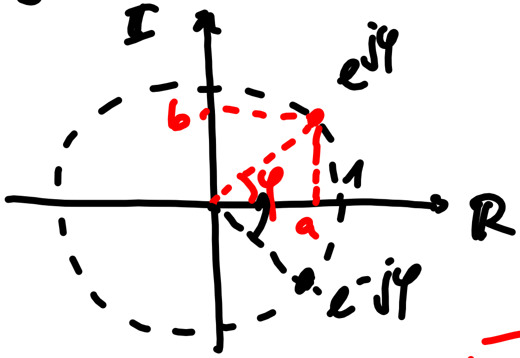
$z + z^* = 2a$

$zz^* = re^{j\varphi} \cdot re^{-j\varphi} = r^2$

np.pow(~~np.abs~~(z), 2.0)

z * np.conj(z)

jednotková kružnice



$|e^{j\varphi}| = 1$

$a = \cos\varphi$

$b = \sin\varphi$

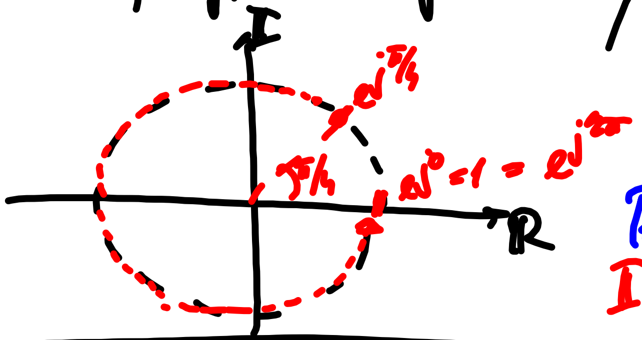
$e^{j\varphi} + e^{-j\varphi} = 2\cos\varphi$

$$\cos\varphi = \frac{e^{j\varphi} + e^{-j\varphi}}{2}$$

---

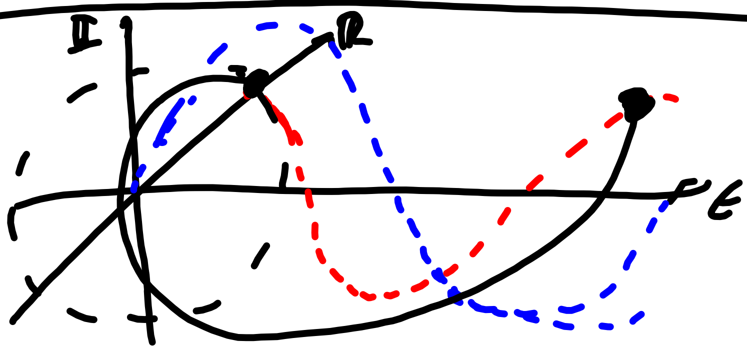
komplexní exponenciála

$x(t) = e^{jt}$



$\mathcal{R}(e^{jt}) = \cos t$

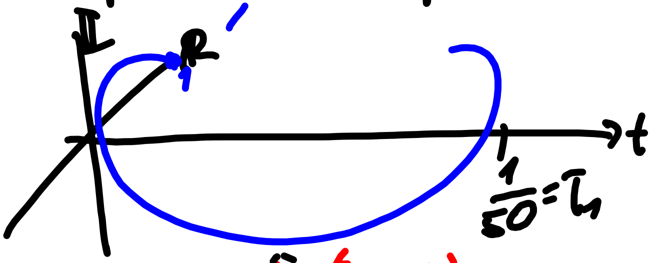
$\mathcal{I}(e^{jt}) = \sin t$



- fázor
- python/Matlab

Operace s komplex. exp.

$e^{a+b} = e^a \cdot e^b$



$1 \cdot e^{j 2\pi \frac{t}{T_1}}$

$\frac{1}{T_1} = f_1$

$60\, e^{j 2\pi \frac{t}{T_1}}$

$\frac{2\pi}{T_1} = \omega_1$

$60\, e^{j(2\pi \frac{t}{T_1} + \varphi_1)}$

$x(t) = C_1 e^{j(\omega_1 t + \varphi_1)} = C_1 e^{j\varphi_1} \cdot e^{j\omega_1 t}$

jak tlustá — jak předtočená!