

Půlsem:  
zadání a ref. řešení bande na webu ISS.

OPAK: spek. analýza sig. se spoj. časem

$$X(j\omega) = \int_{-\infty}^{\infty} x(t) e^{-j\omega t} dt \quad \leftarrow \text{Four. transformace}$$

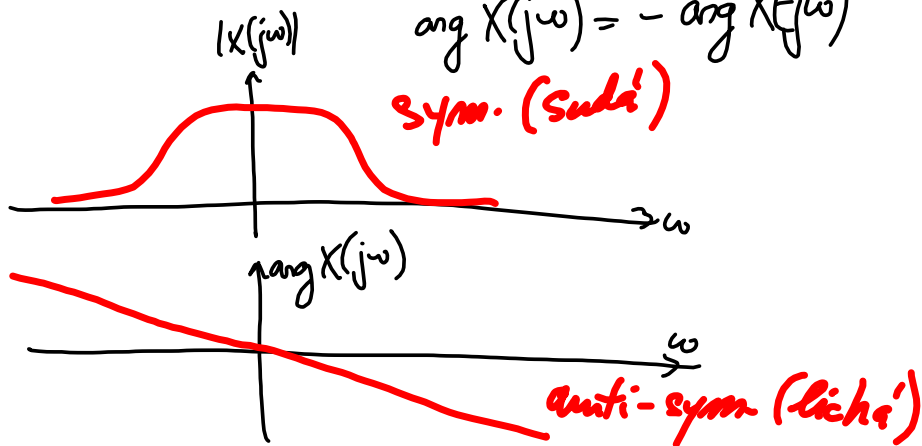
↑  
spektrální funkce

podud  $x(t) \in \mathbb{R}$ , pak

$$|X(j\omega)| = |X(-j\omega)|$$

$$\arg X(j\omega) = -\arg X(-j\omega)$$

$$X(j\omega) = X^*(-j\omega)$$

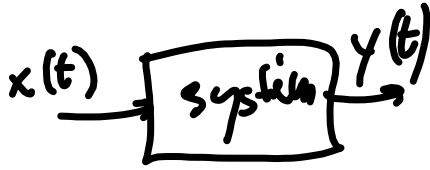


# Systemy

Vlastnosti

① kausalita

$$y(t) = f(x(\tau \leq t), y(\tau < t))$$



$$y[n] = f(x[m \leq n], y[m < n])$$

② Stabilita

bounded input  $\rightarrow$  bounded output

$$|x(t)| < B \rightarrow |y(t)| < C$$

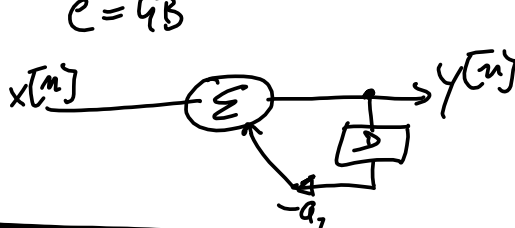
$$|x[n]| < B \rightarrow |y[n]| < C$$

$$\begin{matrix} +1 & -1 & +1 & -1 \\ B & -B & B & -B \end{matrix}$$

$\underbrace{\hspace{10em}}_{4B}$

$$C = 4B$$

Stabilita



$\rightarrow \pm \infty$   
 $|a| < 1$  stab.  
 $a_1 > 1$  nestab.

③ Casova invariance

$$x(t) \rightarrow y(t)$$

$$x(t - \text{nico}) \rightarrow y(t - \text{nico})$$

$$x[n] \rightarrow y[n]$$

$$x[n - \text{smajlik}] \rightarrow y[n - \text{smajlik}]$$

④ Linearita

aditivita

$$x_1(t) \rightarrow y_1(t)$$

$$x_2(t) \rightarrow y_2(t)$$

$$x_1(t) + x_2(t) \rightarrow y_1(t) + y_2(t)$$

scaling

$$x(t) \rightarrow y(t)$$

$$a x(t) \rightarrow a y(t)$$

linearita

$$x_1(t) \rightarrow y_1(t)$$

$$x_2(t) \rightarrow y_2(t)$$

$$a x_1(t) + b x_2(t) \rightarrow a y_1(t) + b y_2(t)$$

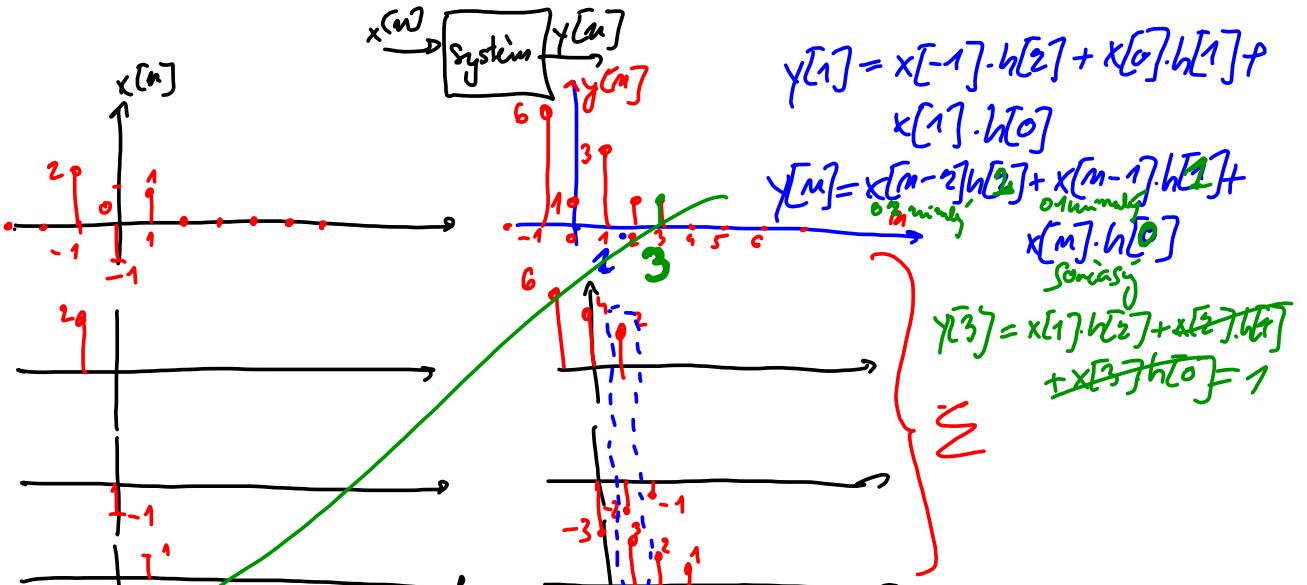
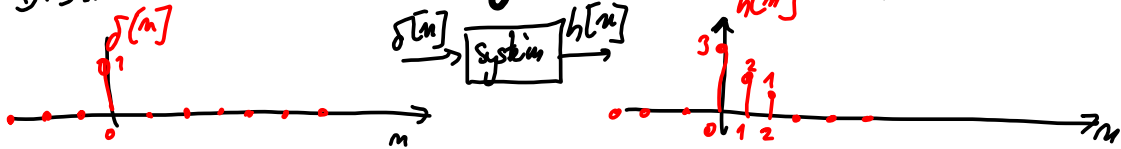
"linearni"  
 "schvaca lin. kombinac."

LTI - linearni a casove invariantni systemy  
 Divide et impera

# Systemy - impulsní odezva a reakce na libovolný vstup

Diskrétu čas

impulsní odezva



$$y[1] = x[-1] \cdot h[2] + x[0] \cdot h[1] + x[1] \cdot h[0]$$

$$y[m] = x[m-2] \cdot h[2] + x[m-1] \cdot h[1] + x[m] \cdot h[0]$$

$$y[3] = x[1] \cdot h[2] + x[2] \cdot h[1] + x[3] \cdot h[0] = 1$$

$$y[n] = \sum_{k=0}^n x[n-k] h[k]$$

← konvoluce!

$$y[n] = x[n] * h[n]$$

$$\left( = \sum_{k=n-2}^n x[k] h[n-k] \right)$$

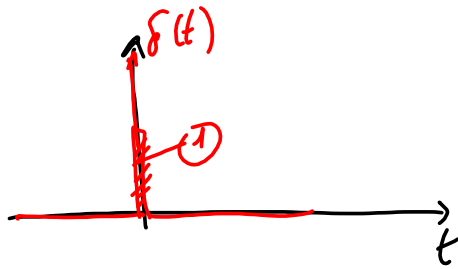
C:

$$y[n] = h_0 * x[n] + h_1 * x[n-1] + h_2 * x[n-2]$$

↑ jine v C-čís, \* je násobení

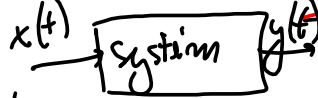
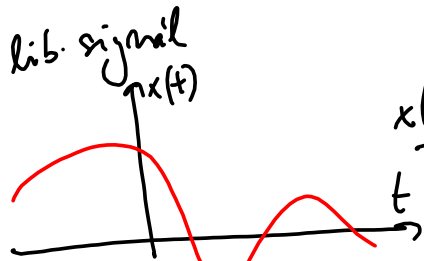
# Systemy se spojitým časem - LTI

$$y[n] = \sum_{k=-\infty}^{\infty} x[n-k]h[k]$$



system

$h(t)$  impulsní odezva



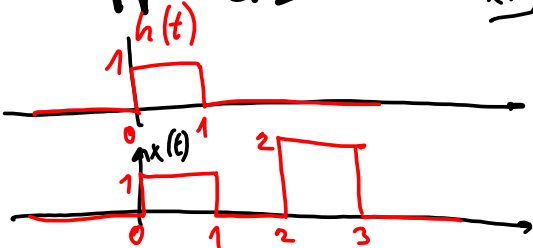
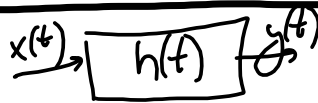
konvoluce

$$y[n] = \sum_{k=-\infty}^{\infty} h[k]x[n-k]$$

DISK. ČAS

$$y(t) = \int_{-\infty}^{\infty} h(\tau)x(t-\tau)d\tau = \int_{-\infty}^{\infty} x(\tau)h(t-\tau)d\tau$$

## PŘÍKLAD



## Frekvenční analýza syst. se spoj. časem.

$h(t)$  - impulsní odezva

$H(j\omega)$  - komplexní limitová/frekvenční charakteristika  
frequency response.

$$H(j\omega) = \text{FT}[h(t)] = \int_{-\infty}^{\infty} h(t) e^{-j\omega t} dt$$

$$H(j\omega) = H^*(-j\omega)$$

modul  
JAK MOC?

arg  
JAK POSUNUTÍ?