Dekodiranje cikličnih kodov

$$\vec{z} \rightsquigarrow \vec{x} \rightsquigarrow \vec{y} = \vec{x} + \vec{e} \rightsquigarrow \vec{s} = ?$$

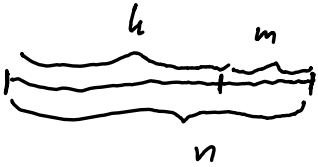
$$\vec{y}(p) = x(p) + z(p)$$

$$z(p) \cdot g(p) + e(p)$$

$$y(p) = g(p) \cdot Q(p) + s(p)$$

$$\hookrightarrow s(p) = y(p) \bmod g(p)$$

$$st[s(p)] < m$$



$$y(p) \cdot p^i = x(p)\, p^i + \underbrace{e(p)\, p^i}_{s(p)}, \quad i = 0$$

izberemo i, v katerem ima $\hat{e}$ najmanj enic.

tipi napak:

→ posamezne napake $\vec{x} = (000010000)$, $e(p) = p^i$

→ izbruhi napak $x = (000\underbrace{1101}000)$

Zadaj jih uporabljamo (zmožnosti cikličnih kodov)

Odkrijejo posamezne napake

$$e(p) = p^i \quad \text{ni deljivo z} \quad g(p) = p^m + \dots + 1$$

Odkrije dvojne napake → za določeno $g(p)$

$$e(p) = p^i + p^j = p^j\,(p^{i-ij} + 1)$$

Odkrije liho št. napak, če $g(p)$ vključuje $(p+1)$ → sodo št. členov!

$$(p^i + p^j)(p+1) = p^{i+1} + p^i + p^{j+1} + p^j \qquad , i > j-1$$

$$(p^i + p^{i-1})(p+1) = p^{i+1} \quad \cancel{p^j} + \cancel{p^j} + p^{i-1}$$

Odkrijejo vse izbruhe do dolžine m

Odkrijejo vse razen $\frac{1}{2^{m-1}}$ iz bruhov dolžine $m+1$

$$g(p) = p^m + g_{m-1} p^{m-1} + \cdots + g_1 p_1$$

Odkrijejo vse razen $\frac{1}{2^m}$ iz bruhov dolžine $> m+1$

Popravijo:

→ $\lfloor \frac{d_{m-1}}{2} \rfloor$ posamičnih napak

→ izbruhe do dolžine $\lfloor m/2 \rfloor$

Cikličnі kodi v praksi

LFSR

→ začetne vrednosti pomnilnih celic

→ XOR na izbranih bitih (negacija)

→ vrstni red bitov v bajtu

→ vrstni red bajtov

CRC-16-ANSI

m

$g(p) = p^{16} + p^{15} + p^2 + 1$

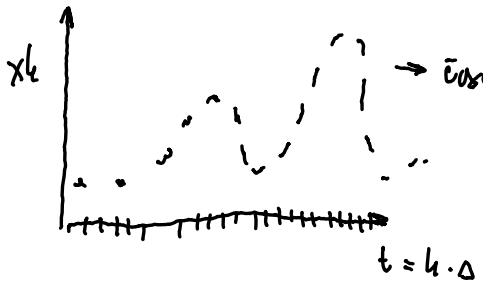
1 1000 0000 0000 0101

m 1 8 0 0 5

$0_x 8005$

	CRC-16-ANSI	CRC-16-CCITT	CRC-32-IEEE
polinom	0x8005	0x1021	0x04C11DB7
registri (1)	0x0000	0xFFFF	0xF....F
XOR (2)	0x0000	0x000	0xF....F
zrcaljenje bitov (3)	da	ne	da
zrcaljenje bajtov (4)	da	ne	da
uporaba	USB	bluetooth	Ethernet
$V_{2^{m-1}}$	$7.1 \cdot 10^{-5}$	$7 \cdot 1 \cdot 10^{-5}$	$4.6 \cdot 10^{-10}$

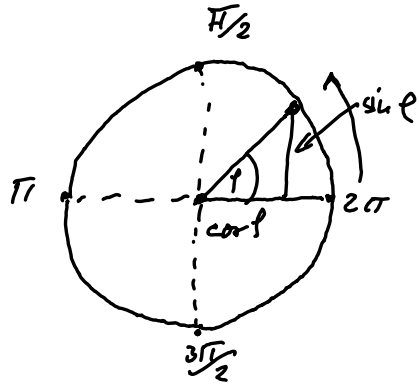
7. Sistemi



→ časovna vrsta

Δ perioda vzorčenja

$$\Delta = \frac{1}{\nu_s} \quad , \quad \nu_s = \frac{1}{\Delta}$$

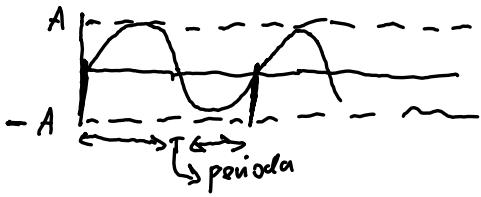


Frekvenca

→ invariantnost sinusoid

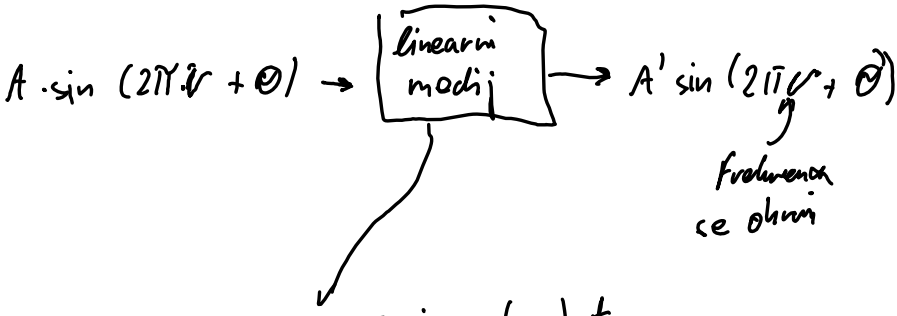
$$x(t) = A \cdot \sin\left(\frac{i\pi}{T} + \Theta\right)$$

$$= A \cdot \sin\left(2\pi\nu t + \Theta\right)$$

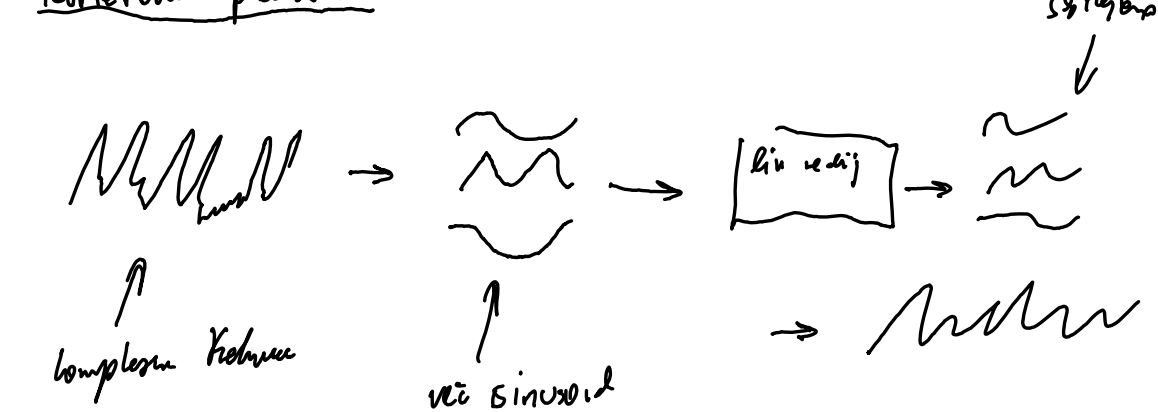


$\nu = 1/T$

$\omega = 2\pi\nu$



→ Fourierova predstavitev

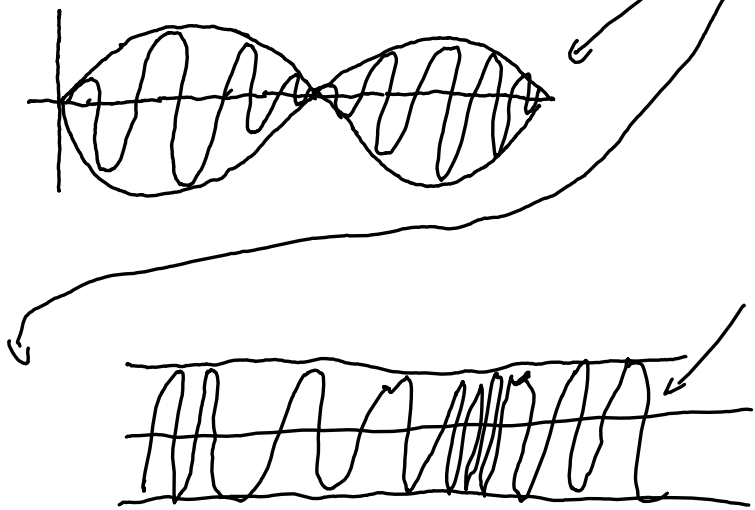


→ Resonanca

Modulacija + Kalmančin prenik

AM $x(t) = (1 + a \cdot s(t)) \cdot \sin(w_0 \cdot t)$

FM $x(t) = \sin[w_0 + a\, s(t) \cdot t]$



$s(t) = \sin(w \cdot t)$

$$x(t) = (1 + a \cdot \sin(wt)) \cdot \sin(w_0 \cdot t) =$$

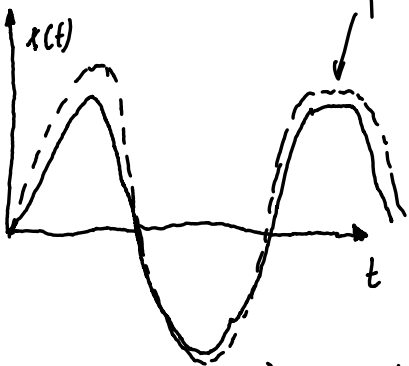
$$= \sin(w_0 t) + \tfrac{a}{2}\left[\cos(w_0 - w)t - \cos[(w_0 + w)t]\right]$$

→ **Vzorčenje**

$V_s \geq 2\, V_{max}$

7.1 Fourierova vrsta

→ periodični signali



približek sinusne funkcije

$x(t+T) = x(t)$

T ... perioda

$\nu_0 = \frac{1}{T}$

$\omega_0 = 2\pi \cdot \nu_0 = \frac{2\pi}{T}$

$\sin(\omega_0 t)$, $\sin(n\,\omega_0 t)$

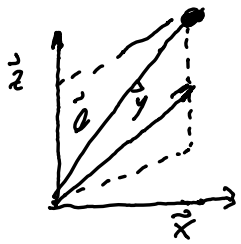
$\cos(\omega_0 t)$, $\cos(n\,\omega_0 t)$

$n = 2, \ldots, \infty$

osnovni harmonik

višji harmoniki

Funkcijsko polni sistem ortogonalen



$$x(t) = \frac{a_0}{2} + \sum_{n=1}^{\infty} a_n \cos(n w_0 \cdot t) + \sum_{n=1}^{\infty} b_n \sin(n w_0 t)$$

$$x(t+T) = x(t)$$

$$\int_0^T \cos(w_0 t)\, dt = \frac{\sin(w_0 \cdot t)}{w_0}\Bigg|_0^T = \frac{\sin(2\pi)}{w_0} - \frac{\sin(0)}{w_0} = 0$$

$$w_0 = \frac{2\pi}{T}$$

$$\int_0^T \cos(n \cdot w_0 t)\, dt = 0$$

$$\int_0^T \sin(n \cdot w_0 t)\, dt = 0$$

$$\int_0^T \cos(n \cdot w_0 \cdot t) \cdot \cos(m \cdot w_0 \cdot t)\, dt$$

$$\frac{1}{2}\int_0^T \left(\cos[(n+m)\, w_0 t] + \cos[(n-m)\, w_0 t]\right) dt$$

1.) $n \neq m \Rightarrow 0$

2.) $n = m \Rightarrow \frac{1}{2}\int_0^T \underbrace{\cos 0}_{1}\, dt = T/2$

$$\int_0^T \sin(n \cdot w_0 t) \cdot \sin(m \cdot w_0 t)\, dt = \begin{cases} 0, & n \neq m \\ T/2, & n = m \end{cases}$$

$$\int_0^T \underbrace{\sin(n \cdot w_0 t) \cdot \cos(m \cdot w_0 t)}_{\text{ung. F}}\, dt = 0$$