$$\hat{V}_a(s) = \sum \alpha_k e^{-s2k\tau} = \sum \alpha_k \cdot e^{-skT} =$$

$$2\tau = T$$

$$= \sum_{k=0}^{\infty} \alpha_k \left(e^{sT}\right)^{-k}$$

Trans. vr. kont. filt

→ u vr. diskret.

Met. Jed. Imp. Odz.

$s \to z = e^{sT}$ ← T.. period otipk.

$$\hat{V}_a(z) = \sum_{k=0}^{\infty} \alpha_k \cdot z^{-k}$$

uzorci impul. odziva sustava $V(z)$

prijen. funk. VT u vr. disk. dom.

bash. 10

pomak $e^{-sN\tau} = e^{-sN\cdot\frac{T}{2}} = \left(e^{sT}\right)^{-N/2}$

$z = e^{sT}$

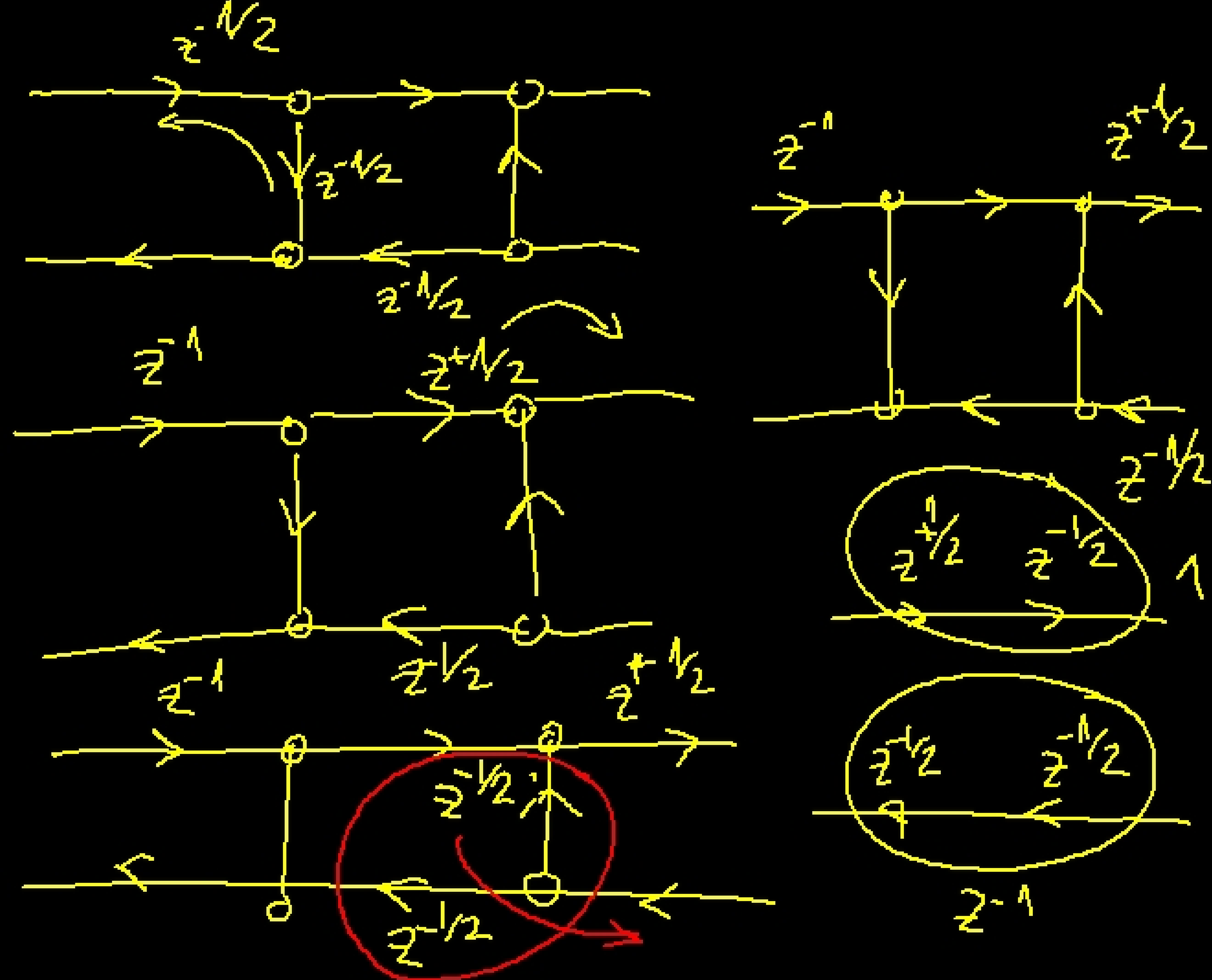
pomak u VDD. je $z^{-N/2}$

za N/2 koraka

To tražimo

$$V_a(z) = \underbrace{z^{-N/2}}_{\text{pomak u vremenu}} \cdot \underbrace{\hat{V}_a(z)}_{\text{određuje form. karak.}}$$

linearni fazni član u sp.



$z^{-1/2}$
$z^{-1/2}$
$z^{-1/2}$
z^{-1}
$z^{+1/2}$
$z^{-1/2}$
z^{-1}
$z^{+1/2}$
$z^{-1/2}$
$z^{-1/2}$
z^{-1}
$z^{+1/2}$
$z^{-1/2}$
$z^{+1/2}$
$z^{-1/2}$
1
$z^{-1/2}$
$z^{-1/2}$
z^{-1}

$$u^+(n) = (1+r)\,w^+(n) + r\,u^-(n)$$

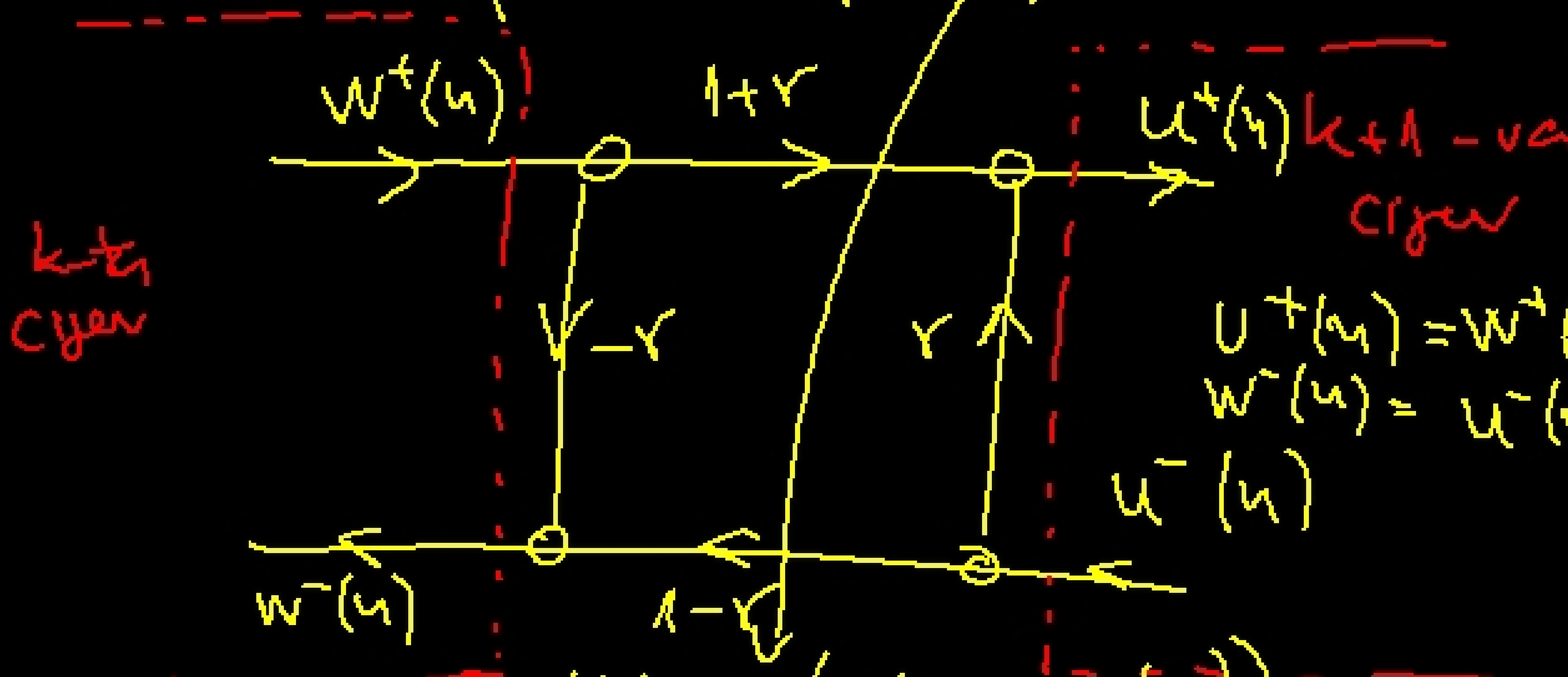
$$w^-(n) = (1-r)\,u^-(n) - r\,w^+(n)$$

$$= w^+(n) + r\,w^+(n) + r\,u^-(n)$$

$$= u^-(n) - r\,u^-(n) - r\,w^+(n)$$

$$r_k = \frac{A_{k+1} - A_k}{A_{k+1} + A_k}$$

faktor refleksije



$$r\,w^+(n) = a(n)$$

$$r\,u^-(n) = b(n)$$

$$u^+(n) = w^+(n) + a(n) + b(n)$$

$$w^-(n) = u^-(n) - b(n) - a(n)$$

$$u^-(n)$$

$$u^+(n) = w^+(n) + r\left(w^+(n) + u^-(n)\right)$$

$$w^-(n) = u^-(n) - r\left(w^+(n) + u^-(n)\right)$$

$$U_L(z) = (1+r_L)\, z^{N/2} \cdot z^{-1} \cdot U_N^+(z)$$

$$U_N^-(z) = -r_L z^{-1} \cdot U_N^+(z)$$

$$U_N(z) = \begin{bmatrix} U_N^+(z) = z^{1-N/2} \cdot \dfrac{1}{1+r_L} \cdot U_L(z) \\ U_N^-(z) = z^{-N/2} \dfrac{-r_L}{1+r_L} U_L(z) \end{bmatrix}$$

$$U_N(z) = \frac{1}{1+r_L} z^{1-N/2} \begin{bmatrix} 1 \\ z^{-1} \cdot (-r_L) \end{bmatrix} U_L(z)$$

$$U_{k+1}^{+}(z) = U^{+}(z)\cdot \cancel{z^{-1}}\cdot(1+r_k) + r_k\, U_{k+1}^{-}(z) \qquad /\cdot r_k$$

$$U_k^{-}(z) = -r_k\cdot \cancel{z^{-1}}\, U_k^{+}(z) + (1-r_k)\cdot U_{k+1}^{-}(z) \qquad /(1+r_k)$$

$$r_k U_{k+1}^{+}(z) + (1+r_k)\, U_k^{-}(z) = (1-\cancel{r_k^2})\ \cancel{r_k^2 U^{-}}_{k+1}(z) + (1-r_k)(1+r_k)\, U_{k+1}^{-}(z)$$

$$U_k^{-}(z) = \frac{1}{1+r_k}\left[-r_k U_{k+1}^{+}(z) + U_{k+1}^{-}(z)\right]$$

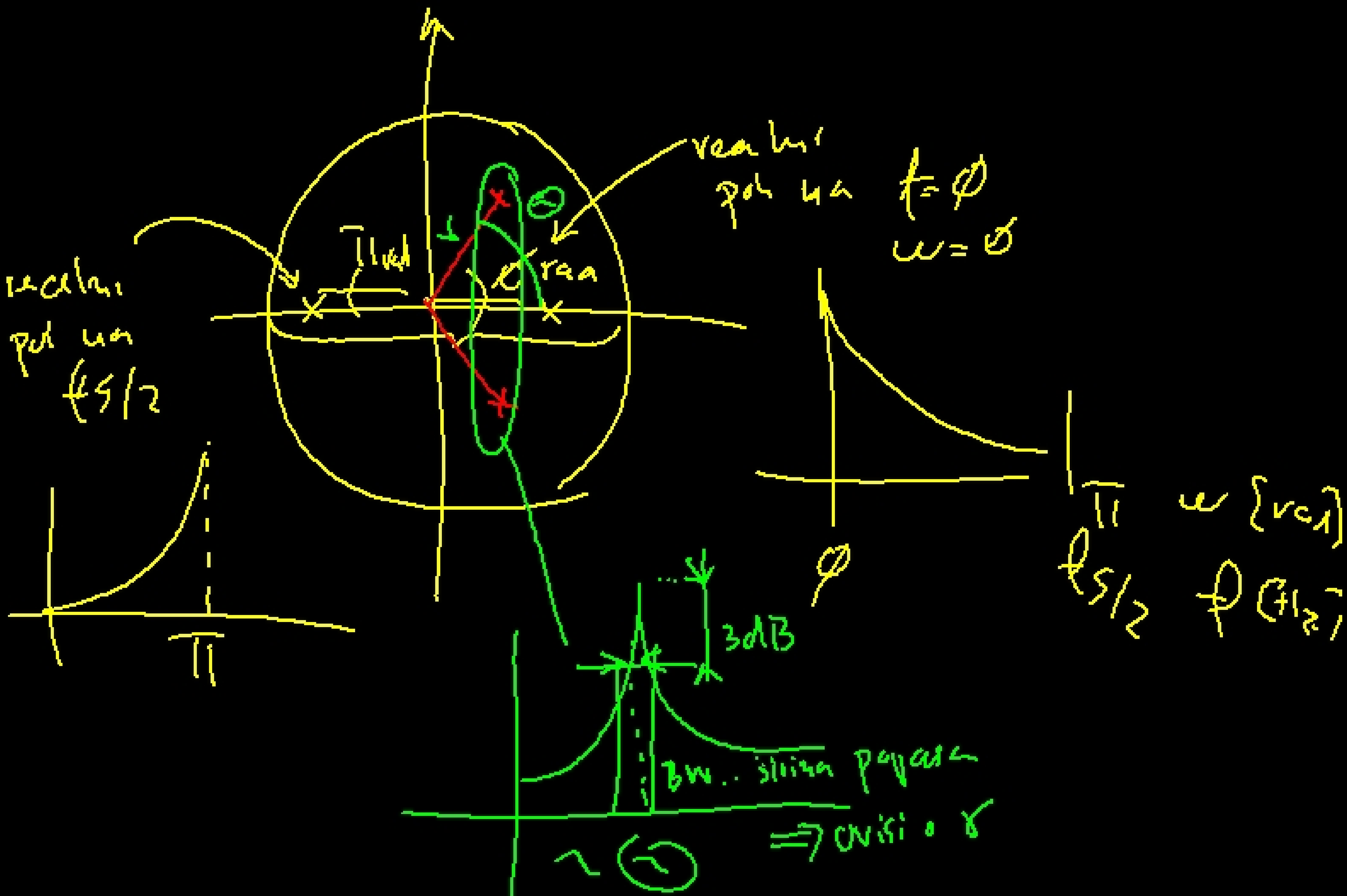
na plas.

$$U_1^+(z) = \frac{(1+r_G)}{2} U_G(z) + r_G \cdot U_1^-(z)$$

$$U_G(z) = \frac{2}{(1+r_G)} \left(U_1^+(z) - r_G U_1^-(z) \right)$$

$$\mathbf{U}_1(z)$$

$$U_G(z) = \frac{2}{(1+r_G)} \begin{bmatrix} 1 & -r_G \end{bmatrix} \begin{bmatrix} U_1^+(z) \\ U_1^-(z) \end{bmatrix}$$



realni pol na fs/2
realni pol na f=0
ω=0
3dB
BW.. širina pojasa
⇒ ovisi o r
ω [rad]
fs/2
0 (Hz)

$$\boxed{r_G = 1}$$

radi pojednostavlj.

$$r_L = \frac{A_{N+1} - A_N}{A_{N+1} + A_N}$$

i $l_{N+1} = \infty$ ... beskonačno duga cijev.

koji presjek A_{N+1} odgovara ideal. zatvj ?

$$r_L = 1 \Rightarrow A_{N+1} = \infty$$

Za A_{N+1} konačan $\Rightarrow$ $|r_L \neq 1|$

... imamo gubitke $\quad r_L = r_N$

faz. rel. na spoju N-te cijevi VT i N+1-ve cijevi koja modelira prostor

Red sustava..

$$T = 2\tau$$

τ.. vrijeme proleta kroz cijev.

l... ukupna duž. VT

N.. broj cijevi

duljina jedne cijevi $\Delta X = \frac{l}{N} \Rightarrow \tau = \frac{\Delta X}{c}$

$$\tau = \frac{l}{Nc} = \frac{T}{2} = \frac{1}{2 f_s}$$ f_s... frek. otip.

$$f_s = \frac{Nc}{2l} \Bigg/ \begin{matrix} c = 350\,m/s \\ l = 17.5\,cm \end{matrix} \Bigg/ = N \cdot 1000\ [Hz]$$

npr. ako je $f_s = 10\,kHz$
tada do $5\,kHz$ koliko je $f_s/2$
imamo 5 formanata na
pribl. razmaku od 1000 Hz

$\Rightarrow$ svaki formant. traži $\underbrace{2 \text{ red}}_{\text{par polova}}$ sustava

$\Rightarrow$ potrebno je $N=10$ polova za modeliranje
svih 5 form.

veći f_s traži viši N

manji L $\Rightarrow$ veći razmak form., pa je i niži red N
dovoljan za mod. svih form.