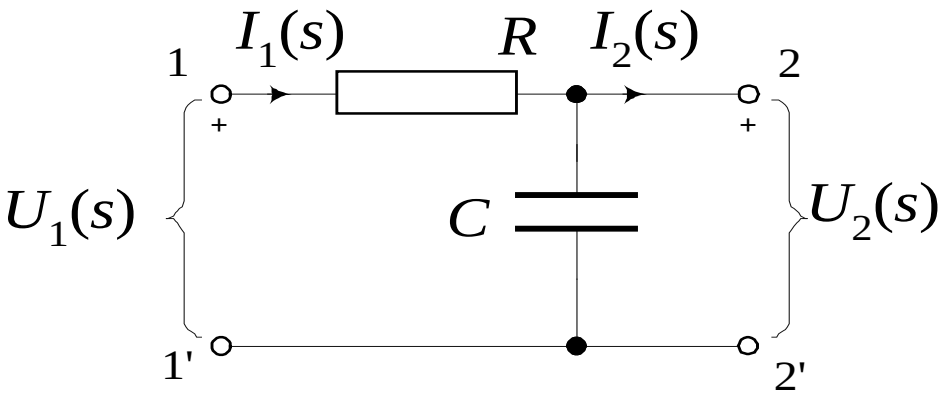
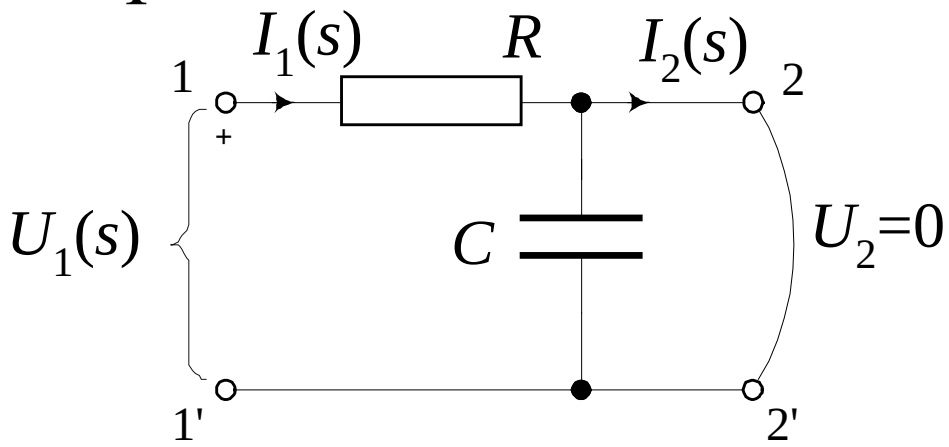
Električni krugovi

Četveropoli-primjeri

Skripta: M. Plohl, Teorija četveropolnih sistema, 1987. , I-dio

- Primjer 1.: *y*-parametri RC četveropola



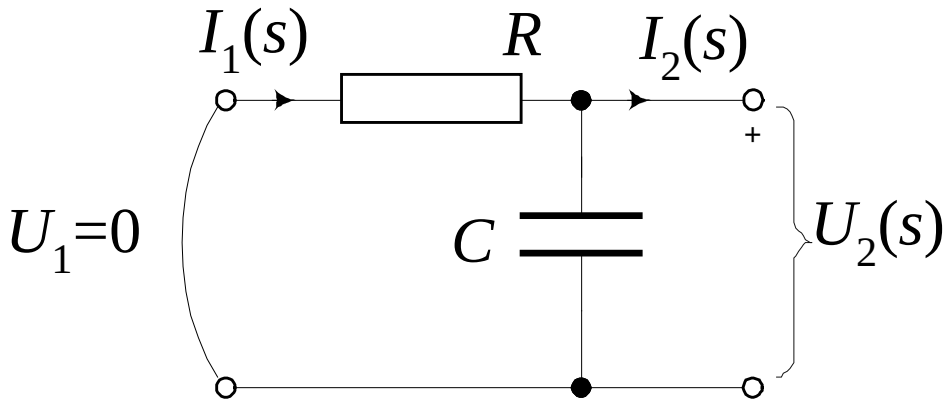


- $\underline{U_2=0}$ → kratki spoj na 2-2'

$$y_{11} = \frac{1}{R}$$

$$y_{21} = \frac{1}{R}$$

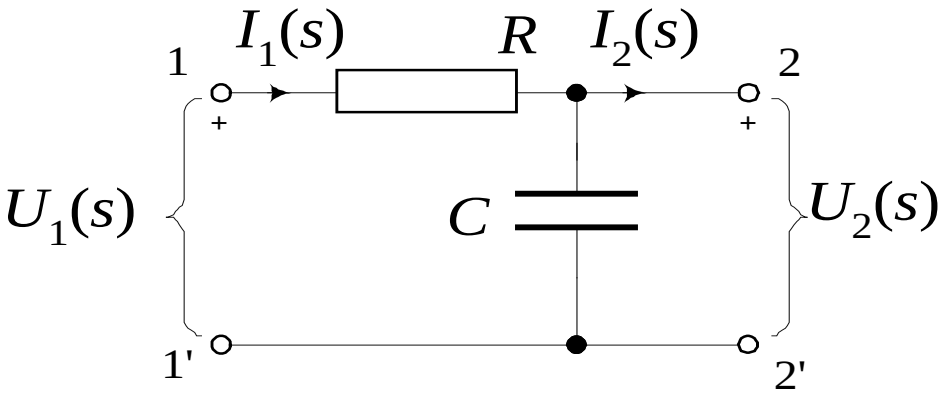
- $\underline{U_1=0}$ → kratki spoj na 1-1'



$$y_{12} = \frac{1}{R}$$

$$y_{22} = \frac{1}{R} + sC$$

- Jednadžbe čvorišta



$$I_1(s) = \frac{1}{R}U_1(s) - \frac{1}{R}U_2(s)$$

$$I_2(s) = \frac{1}{R}U_1(s) - \left(\frac{1}{R} + sC\right)U_2(s)$$

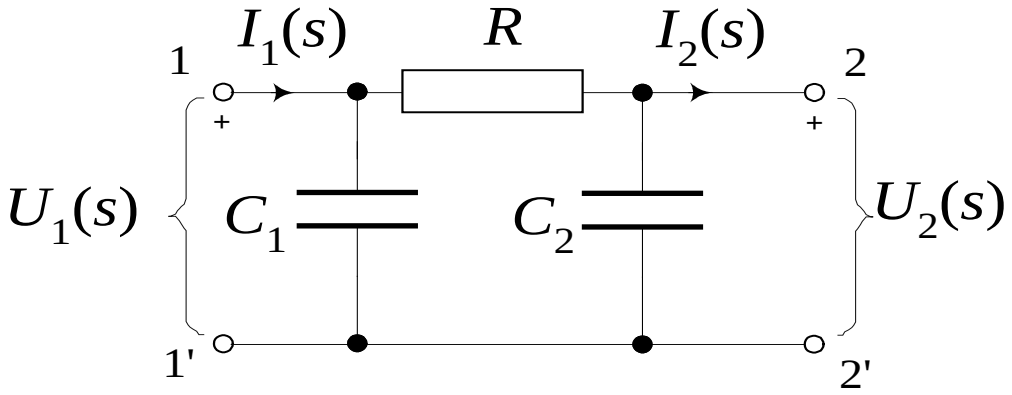
$$I_1 = U_1 y_{11} - U_2 y_{12}$$

$$I_2 = U_1 y_{21} - U_2 y_{22}$$

$$y_{11} = \frac{1}{R} \qquad y_{12} = \frac{1}{R}$$

$$y_{21} = \frac{1}{R} \qquad y_{22} = \frac{1}{R} + sC$$

- Primjer 2.: *y*-parametri RC četveropola



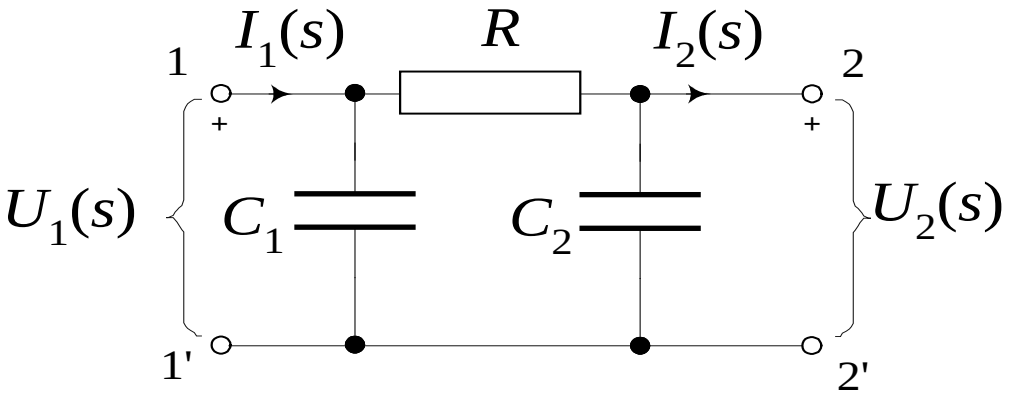
$$y_{11} = \left.\frac{I_1}{U_1}\right|_{U_2=0} = \frac{1}{R} + sC_1$$

$$y_{12} = \frac{1}{R}$$

$$y_{21} = \left.\frac{I_2}{U_1}\right|_{U_2=0} = \frac{1}{R}$$

$$y_{22} = \frac{1}{R} + sC_2$$

- Jednadžbe čvorišta



$$I_1 = U_1 y_{11} - U_2 y_{12}$$

$$I_2 = U_1 y_{21} - U_2 y_{22}$$

$$I_1(s) = \left(\frac{1}{R} + sC_1\right) U_1(s) - \frac{1}{R} U_2(s)$$

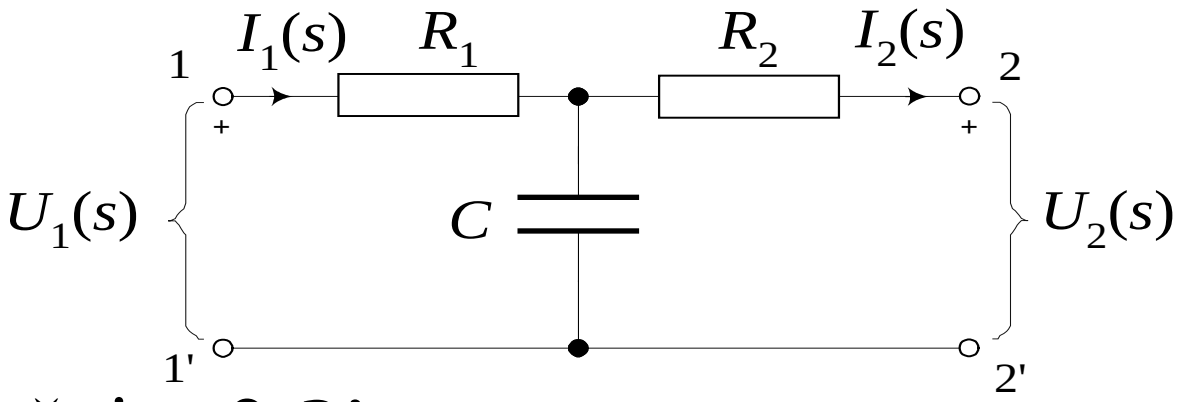
$$I_2(s) = \frac{1}{R} U_1(s) - \left(\frac{1}{R} + sC_2\right) U_2(s)$$

$$y_{11} = \frac{1}{R} + sC_1$$

$$y_{12} = y_{21} = \frac{1}{R}$$

$$y_{22} = \frac{1}{R} + sC_2$$

Primjer 3.: *z*-parametri



$I_2=0$ → otvorene priključnice 2-2'

$$z_{11}=\left.\frac{U_1}{I_1}\right|_{I_2=0}=R_1+\frac{1}{sC}$$

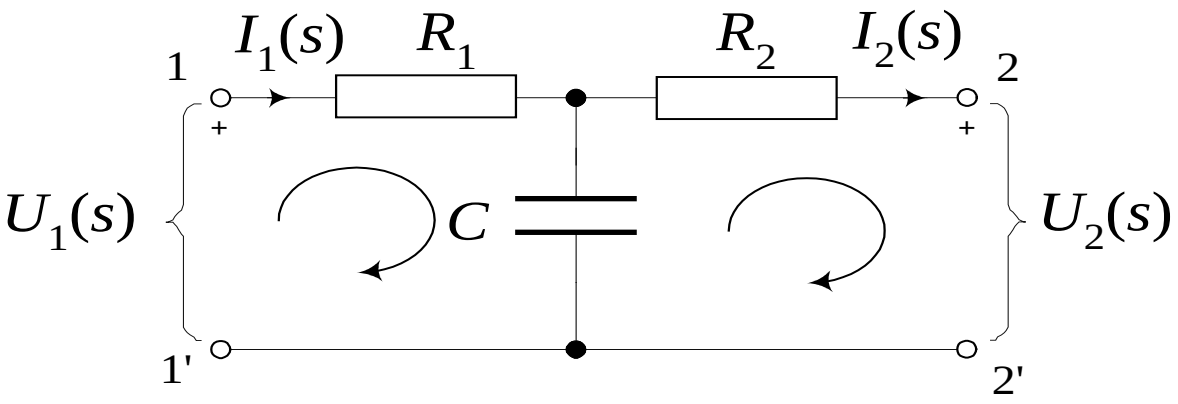
$$z_{21}=\left.\frac{U_2}{I_1}\right|_{I_2=0}=\frac{1}{sC}$$

$I_1=0$ → otvorene priključnice 1-1'

$$z_{12}=-\left.\frac{U_1}{I_2}\right|_{I_1=0}=\frac{1}{sC}$$

$$z_{22}=-\left.\frac{U_2}{I_2}\right|_{I_1=0}=R_2+\frac{1}{sC}$$

- Određivanje z-parametara direktno postavljanjem jednadžbi petlji



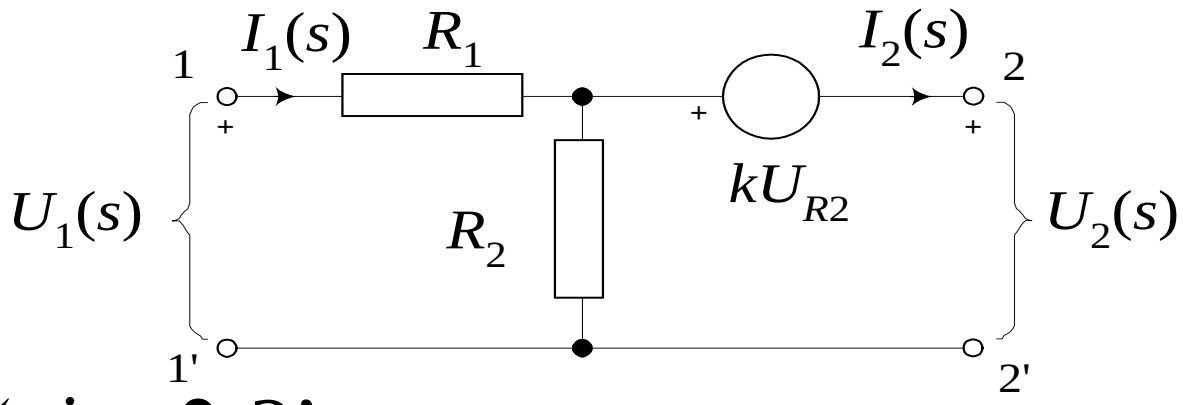
$$U_1 = I_1 R_1 + (I_1 - I_2)\frac{1}{sC}$$

$$-U_2 = (I_2 - I_1)\frac{1}{sC} + I_1 R_2$$

$$U_1 = \left(R_1 + \frac{1}{sC}\right) I_1 - \frac{1}{sC} I_2 \quad = z_{11} I_1 - z_{12} I_2$$

$$U_2 = \frac{1}{sC} I_1 - \left(R_2 + \frac{1}{sC}\right) I_2 \quad = z_{21} I_1 - z_{22} I_2$$

Primjer4.: *z*-parametri



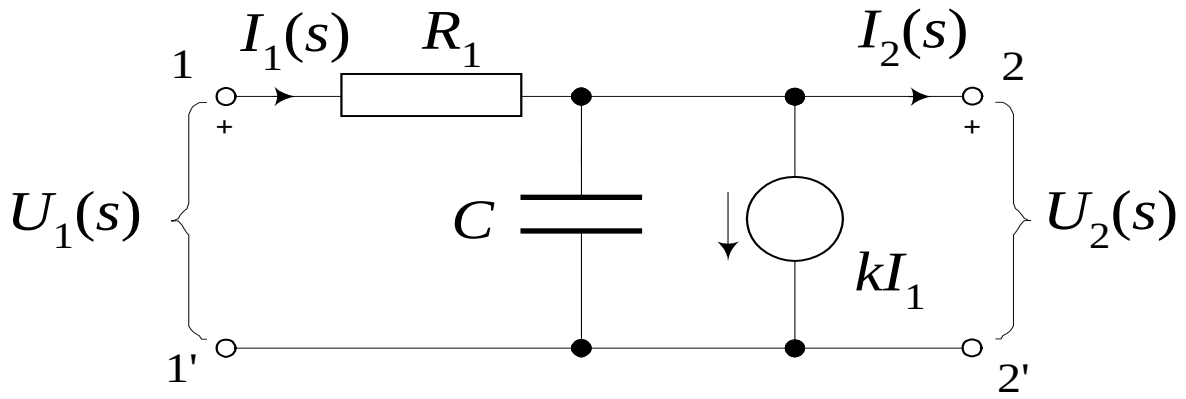
$I_2=0$ → otvorene priključnice 2-2'

$$z_{11}=\left.\frac{U_1}{I_1}\right|_{I_2=0}=R_1+R_2 \qquad z_{21}=\left.\frac{U_2}{I_1}\right|_{I_2=0}=R_2(1-k)$$

$I_1=0$ → otvorene priključnice 1-1'

$$z_{12}=-\left.\frac{U_1}{I_2}\right|_{I_1=0}=R_2 \qquad z_{22}=-\left.\frac{U_2}{I_2}\right|_{I_1=0}=R_2(1-k)$$

Primjer 5.: *a*-parametri



$$U_1 = AU_2 + BI_2$$

$$I_1 = CU_2 + DI_2$$

I_2=0 → otvorene priključnice 2-2'

$$A = \left.\frac{U_1}{U_2}\right|_{I_2=0}$$

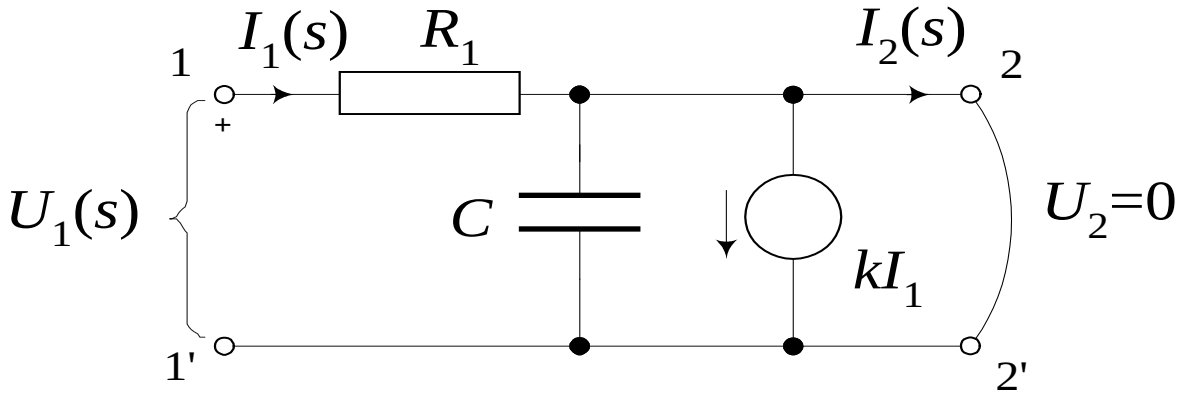
$$\begin{cases} U_1 = I_1 R + \dfrac{1}{sC} I_1 (1-k) \\ U_2 = \dfrac{1}{sC} I_1 (1-k) \end{cases}$$

$$A = 1 + \frac{sCR}{(1-k)}$$

$$C = \left.\frac{I_1}{U_2}\right|_{I_2=0}$$

$$C = \frac{sC}{(1-k)}$$

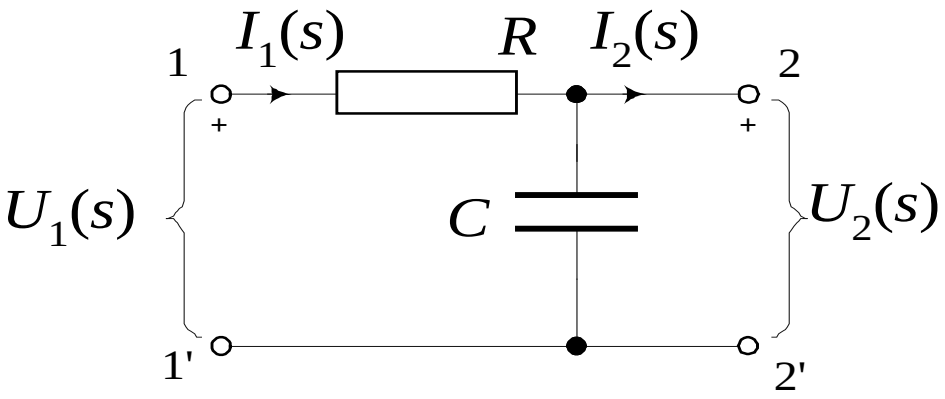
$U_2=0$ → kratko spojene priključnice 2-2’

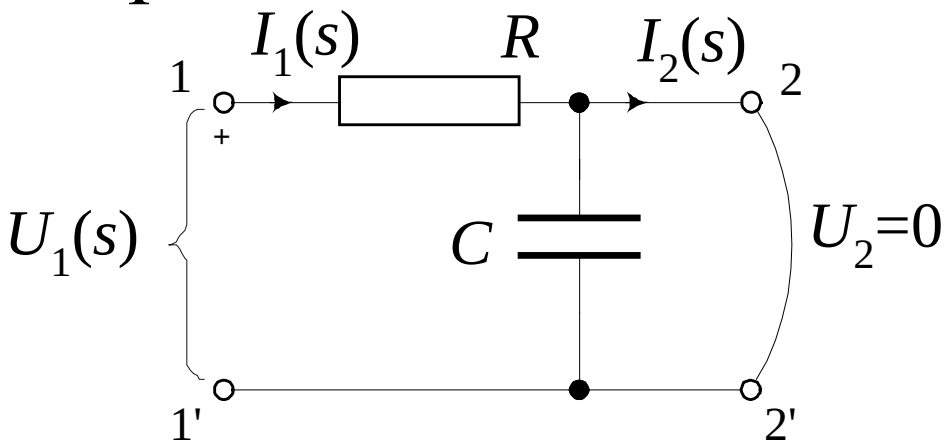


$$B=\left.\frac{U_1}{I_2}\right|_{U_2=0} \qquad U_1=I_1R=\frac{I_2}{1-k}R \qquad \Rightarrow \qquad B=\frac{R}{1-k}$$

$$D=\left.\frac{I_1}{I_2}\right|_{U_2=0} \qquad I_1=\frac{I_2}{1-k} \qquad D=\frac{1}{1-k}$$

- Primjer 6.: *h*-parametri RC četveropola



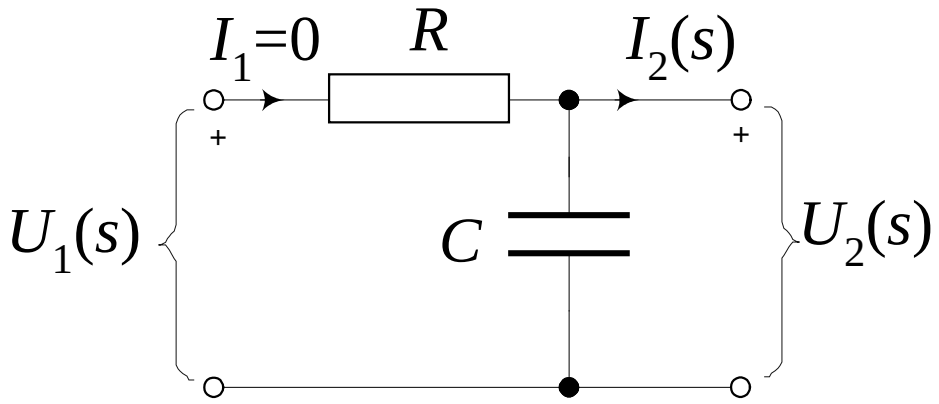


- $\underline{U_2=0}$ → kratki spoj na 2-2'

$$h_{11} = \left.\frac{U_1}{I_1}\right|_{U_2=0} \qquad U_1 = R \cdot I_1 \qquad \Rightarrow \qquad h_{11} = R$$

$$h_{21} = \left.\frac{I_2}{I_1}\right|_{U_2=0} \qquad I_2 = I_1 \qquad \Rightarrow \qquad h_{21} = 1$$

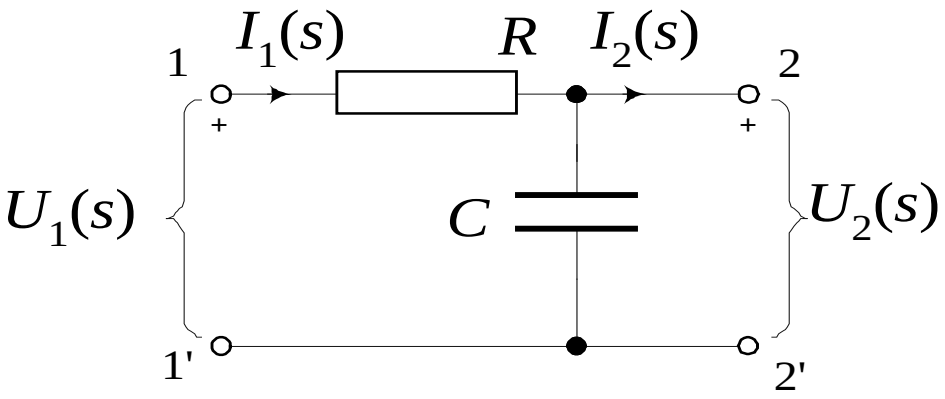
- $I_1=0$ → otvorene 1-1'

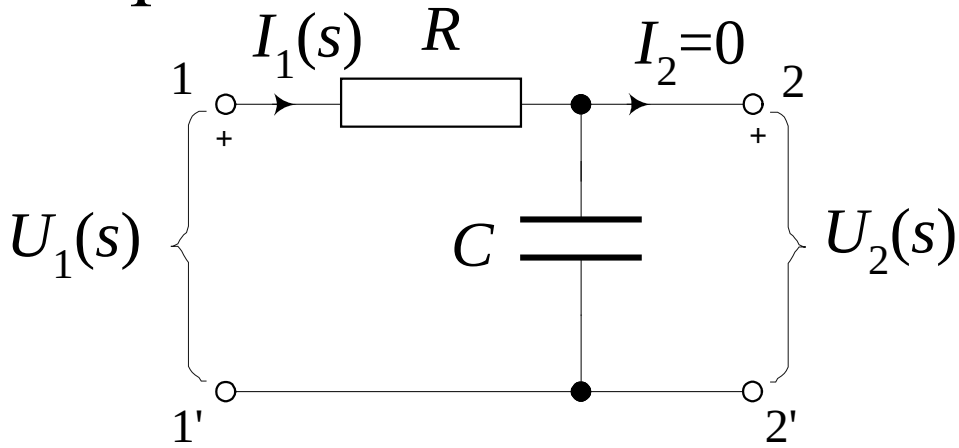


$$h_{12}=\left.\frac{U_1}{U_2}\right|_{I_1=0} \qquad U_2=U_1 \qquad \Rightarrow \qquad h_{12}=1$$

$$h_{22}=\left.\frac{I_2}{U_2}\right|_{I_1=0} \qquad I_2=U_2 sC \qquad \Rightarrow \qquad h_{22}=-sC$$

- Primjer 7.: *g*-parametri RC četveropola



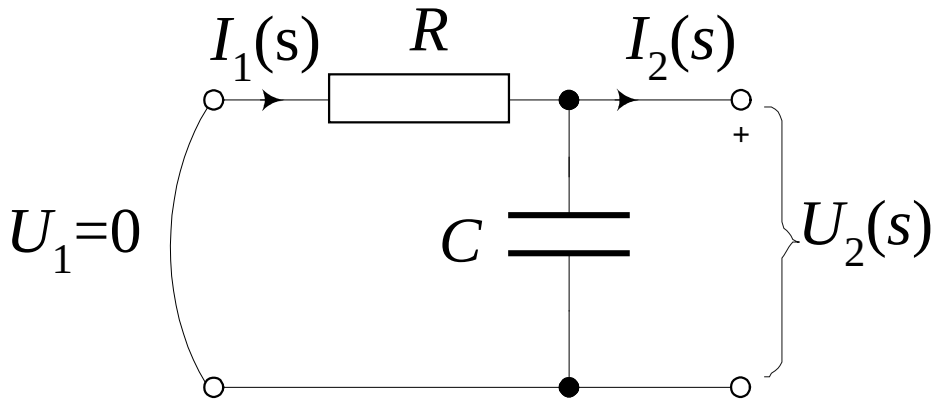


- $\underline{I_2=0}$ → otvorene 2-2'

$$g_{11} = \left.\frac{I_1}{U_1}\right|_{I_2=0} \qquad U_1 = \left(R + \frac{1}{sC}\right)\cdot I_1 \quad \Rightarrow \quad g_{11} = \frac{sC}{sRC+1}$$

$$g_{21} = \left.\frac{U_2}{U_1}\right|_{I_2=0} \qquad U_1 \frac{sC}{sRC+1} = U_2 sC \quad \Rightarrow \quad g_{21} = \frac{1}{sRC+1}$$

- $\underline{U_1=0}$ → kratko spojene 1-1'



$$g_{12} = \left.\frac{I_1}{I_2}\right|_{U_1=0} \qquad I_2\left(\frac{R}{sRC+1}\right) = I_1 R \quad \Rightarrow \quad g_{12} = \frac{1}{sRC+1}$$

$$g_{22} = \left.\frac{U_2}{I_2}\right|_{U_1=0} \qquad I_2 = U_2\left(\frac{1}{R} + sC\right) \quad \Rightarrow \quad g_{22} = -\frac{R}{sRC+1}$$