Chương 2.
MẠNG HAI CỮA

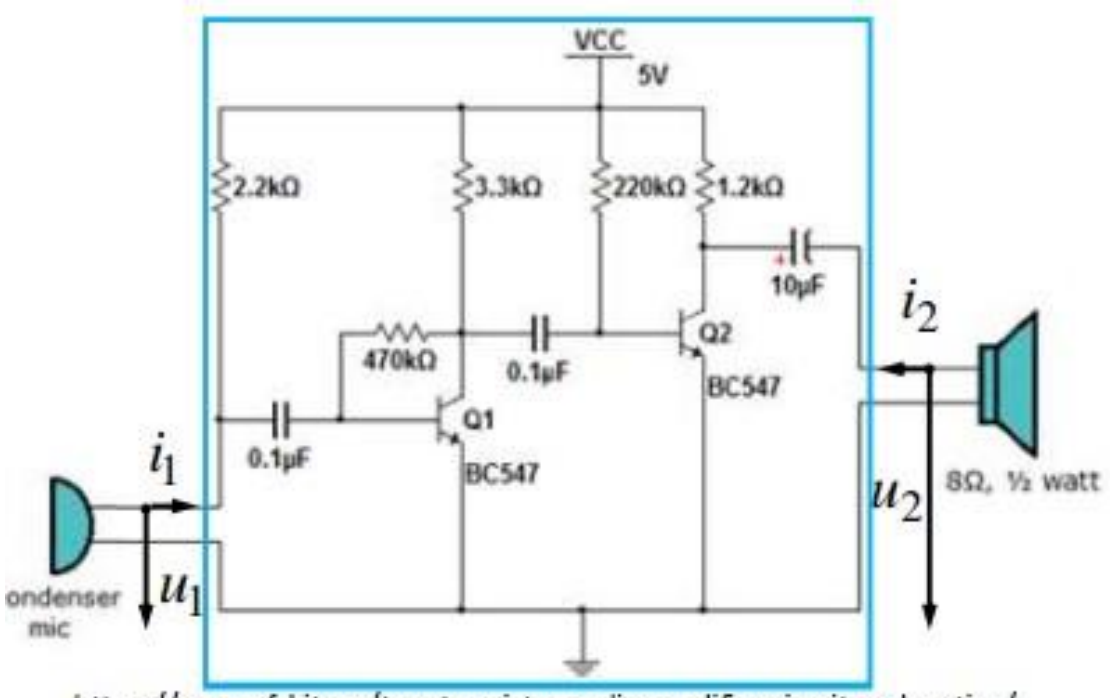
TS. Nguyễn Tiến Dũng

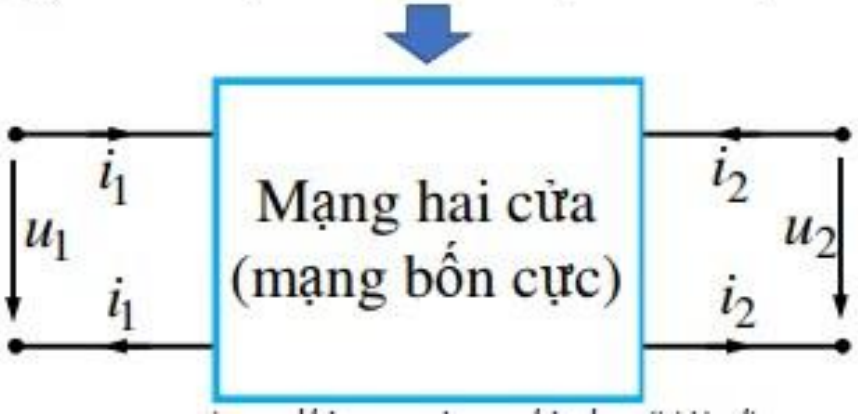
Vinh, 2019

Chương 2. Mạng hai cửa

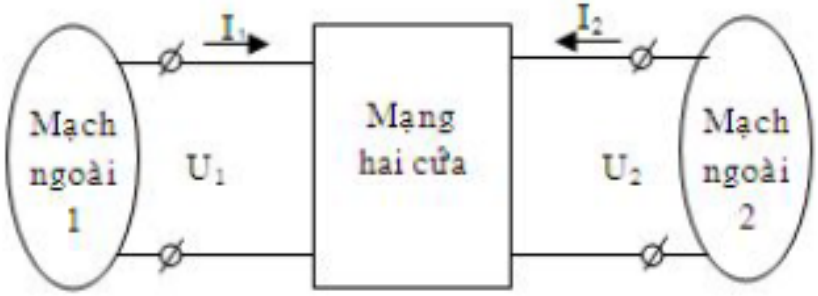
- ✓2.1. Khái niệm mạng 2 cửa
- ✓2.2. Các bộ thông số
- ✓2.3. Quan hệ giữa các bộ thông số
- ✓2.4. Phân tích mạch có mạng 2 cửa
- ✓2.5. Kết nối các mạng 2 cửa
- ✓2.6. Mạng 2 cửa dạng T và π
- ✓2.7. Tổng trở vào và hòa hợp tải
- ✓2.8. Hàm truyền đạt

2.1. Khái niệm mạng 2 cửa

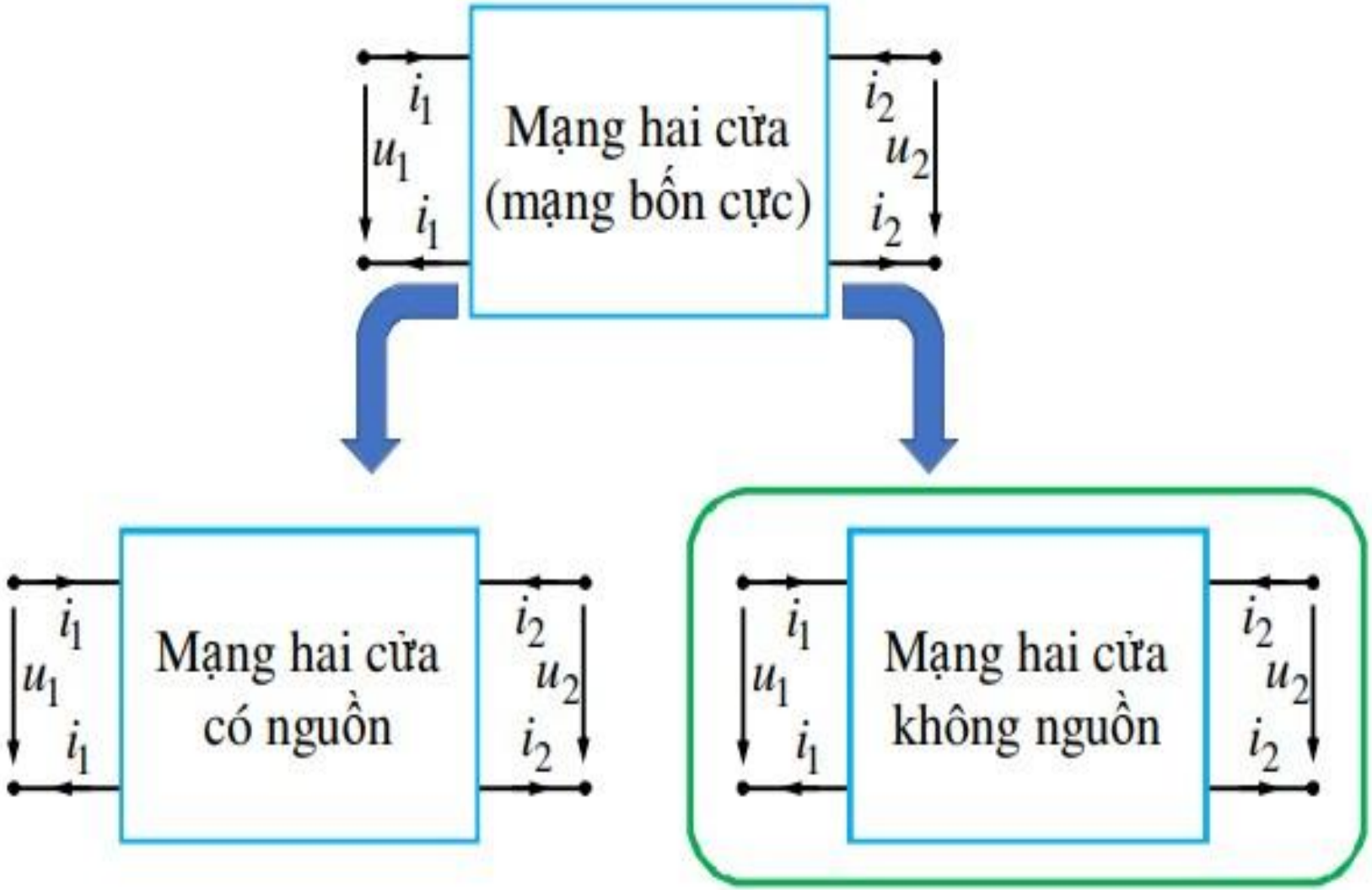




- Mạng hai cửa là mạng trao đổi năng lượng, tín hiệu điện từ với bên ngoài qua hai cửa. Ở mỗi cửa dòng điện chảy vào một cực thì bằng dòng điện chảy ra ở cực kia.

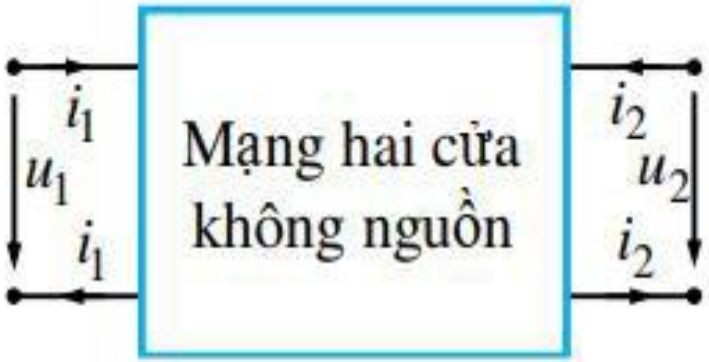


$(U_2, I_2) \rightarrow [A]$	$(I_1, I_2) \rightarrow [Z]$	$(U_1, I_2) \rightarrow [H]$
$(U_1, I_1) \rightarrow [B]$	$(U_1, U_2) \rightarrow [Y]$	$(I_1, U_2) \rightarrow [G]$

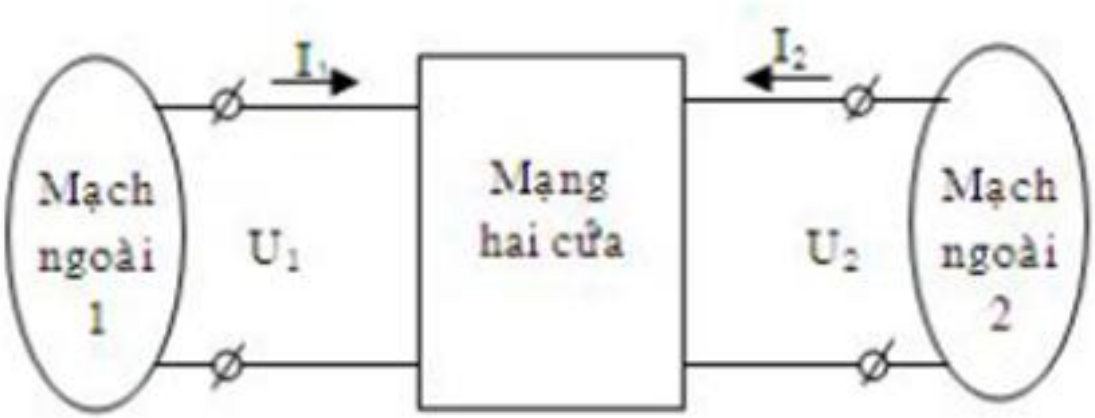

Mạng hai cửa
(mạng bốn cực)
i_1
u_1
i_1
i_2
u_2
i_2
Mạng hai cửa
có nguồn
Mạng hai cửa
không nguồn

Phân tích mạch có mạng hai cửa (đã biết bộ thông số)

Tính bộ thông số của mạng hai cửa



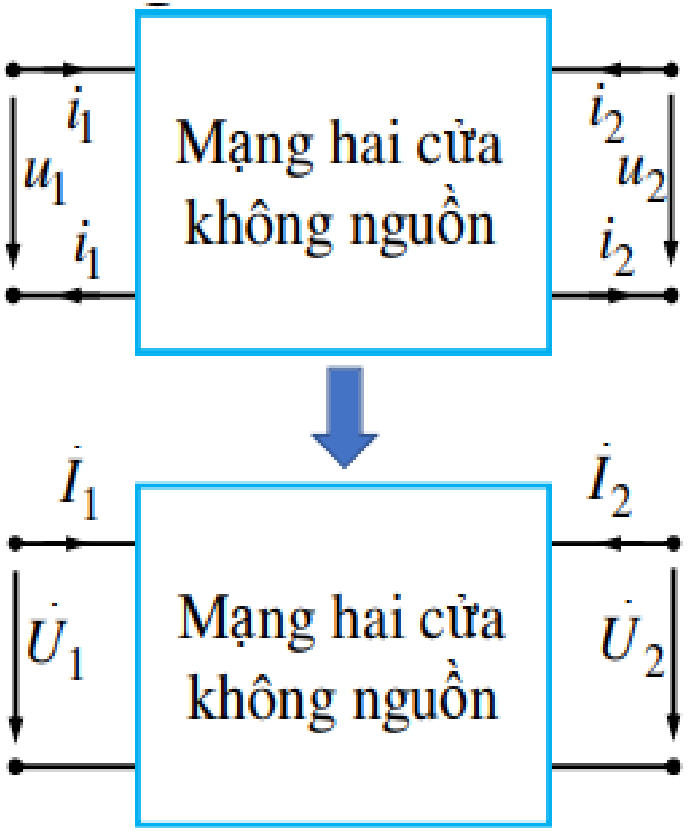
2.2. Các bộ thông số



$(U_2, I_2) \rightarrow [A]$	$(I_1, I_2) \rightarrow [Z]$	$(U_1, I_2) \rightarrow [H]$
$(U_1, I_1) \rightarrow [B]$	$(U_1, U_2) \rightarrow [Y]$	$(I_1, U_2) \rightarrow [G]$

Bộ thông số: Z

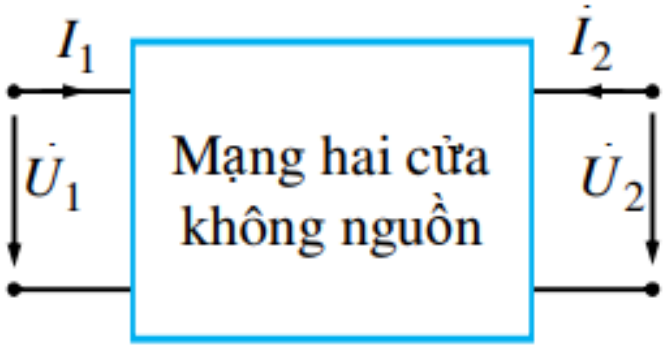
- Còn gọi là bộ số tổng trở.
- Thường được dùng để:
  - Tổng hợp các bộ lọc,
  - Phối hợp trở kháng,…



$$\begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2 \end{cases} \leftrightarrow \begin{bmatrix} \dot{U}_1 \\ \dot{U}_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} \dot{I}_1 \\ \dot{I}_2 \end{bmatrix} = [Z] \begin{bmatrix} \dot{I}_1 \\ \dot{I}_2 \end{bmatrix}$$

Bộ thông số: Z

$$\begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2 \end{cases}$$

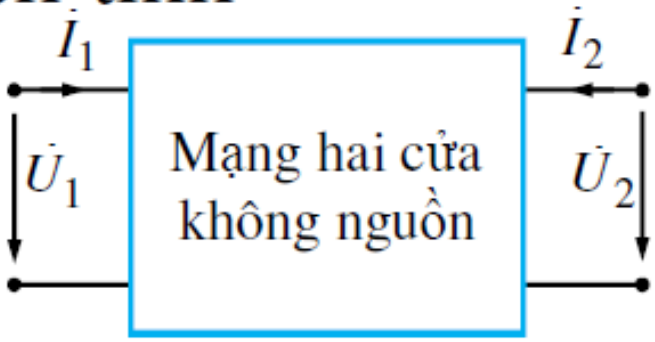


$$\dot{I}_2 = 0 \rightarrow \begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 \\ \dot{U}_2 = Z_{21}\dot{I}_1 \end{cases} \quad \rightarrow Z_{11} = \left.\frac{\dot{U}_1}{\dot{I}_1}\right|_{\dot{I}_2=0}, \quad Z_{21} = \left.\frac{\dot{U}_2}{\dot{I}_1}\right|_{\dot{I}_2=0}$$

$$\dot{I}_1 = 0 \rightarrow \begin{cases} \dot{U}_1 = Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{22}\dot{I}_2 \end{cases} \quad \rightarrow Z_{12} = \left.\frac{\dot{U}_1}{\dot{I}_2}\right|_{\dot{I}_1=0}, \quad Z_{22} = \left.\frac{\dot{U}_2}{\dot{I}_2}\right|_{\dot{I}_1=0}$$

Bộ thông số **Z** (2), cách tính

$$\begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2 \end{cases}$$

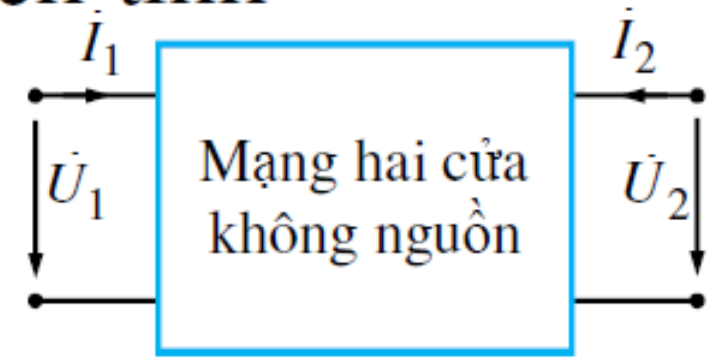


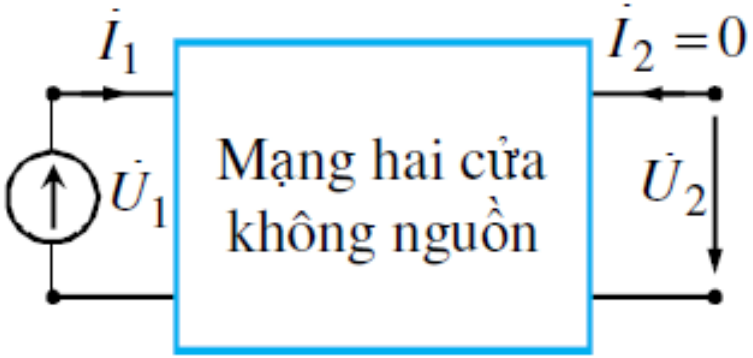
$$\dot{I}_2 = 0 \rightarrow \begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 \\ \dot{U}_2 = Z_{21}\dot{I}_1 \end{cases} \quad \rightarrow Z_{11} = \left.\frac{\dot{U}_1}{\dot{I}_1}\right|_{\dot{I}_2=0}, \quad Z_{21} = \left.\frac{\dot{U}_2}{\dot{I}_1}\right|_{\dot{I}_2=0}$$

$$\dot{I}_1 = 0 \rightarrow \begin{cases} \dot{U}_1 = Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{22}\dot{I}_2 \end{cases} \quad \rightarrow Z_{12} = \left.\frac{\dot{U}_1}{\dot{I}_2}\right|_{\dot{I}_1=0}, \quad Z_{22} = \left.\frac{\dot{U}_2}{\dot{I}_2}\right|_{\dot{I}_1=0}$$

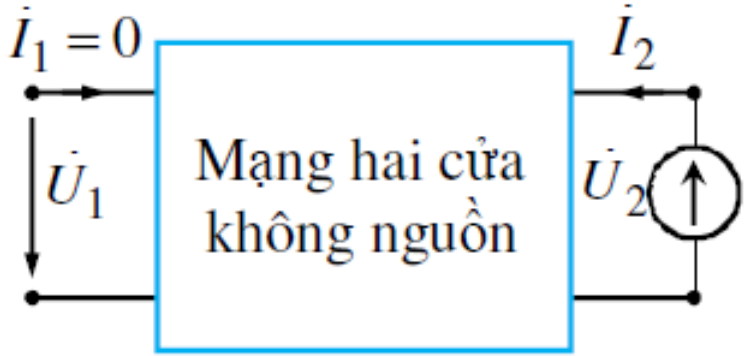
Bộ thông số **Z** (3), cách tính

$$\begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2 \end{cases}$$





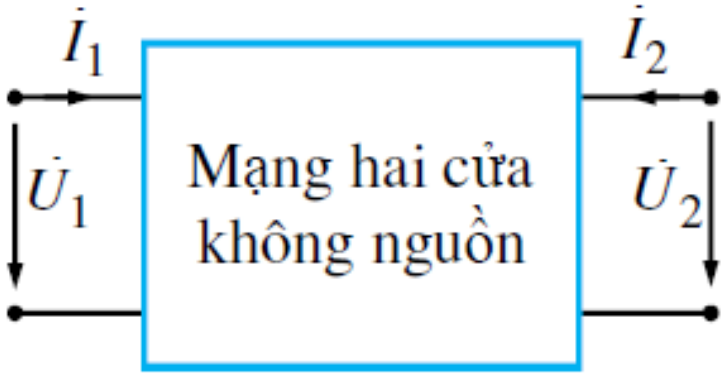
$$\rightarrow Z_{11} = \left.\frac{\dot{U}_1}{\dot{I}_1}\right|_{\dot{I}_2=0}, \quad Z_{21} = \left.\frac{\dot{U}_2}{\dot{I}_1}\right|_{\dot{I}_2=0}$$



$$\rightarrow Z_{12} = \left.\frac{\dot{U}_1}{\dot{I}_2}\right|_{\dot{I}_1=0}, \quad Z_{22} = \left.\frac{\dot{U}_2}{\dot{I}_2}\right|_{\dot{I}_1=0}$$

Bộ thông số **Z** (4)

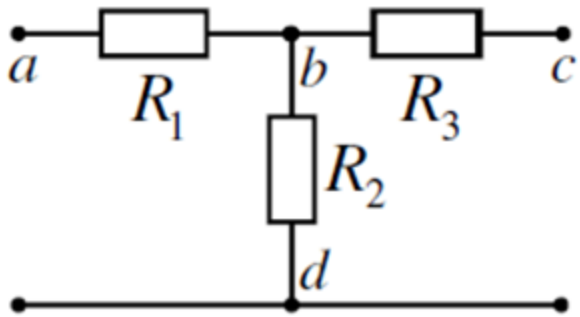
$$\begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2 \end{cases}$$



- Nếu $Z_{11} = Z_{22}$: mạng hai cửa đối xứng
- Nếu $Z_{12} = Z_{21}$: mạng hai cửa tương hỗ
- Có một số mạng hai cửa không có bộ số Z

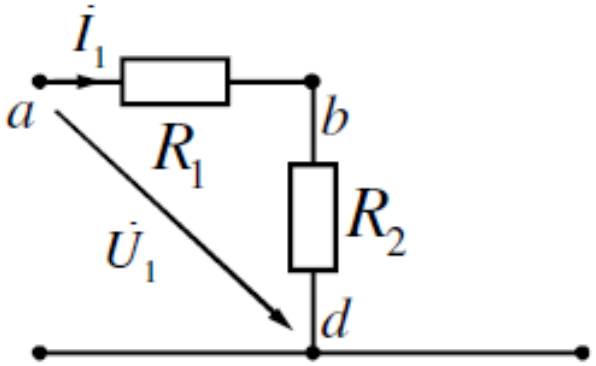
VD1

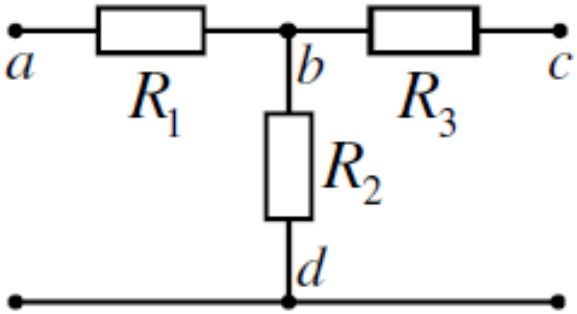
$R_1 = 10\ \Omega; R_2 = 20\ \Omega; R_3 = 30\ \Omega$; Tìm **Z**?

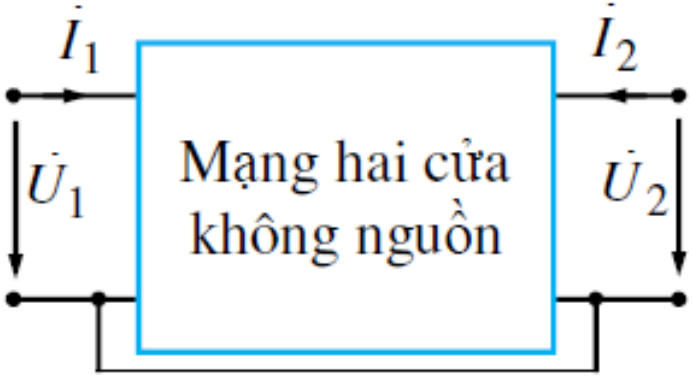


VD1

$R_1 = 10\ \Omega; R_2 = 20\ \Omega; R_3 = 30\ \Omega$; Tìm **Z**?







$$Z_{11} = \left.\frac{\dot{U}_1}{\dot{I}_1}\right|_{\dot{I}_2=0}$$

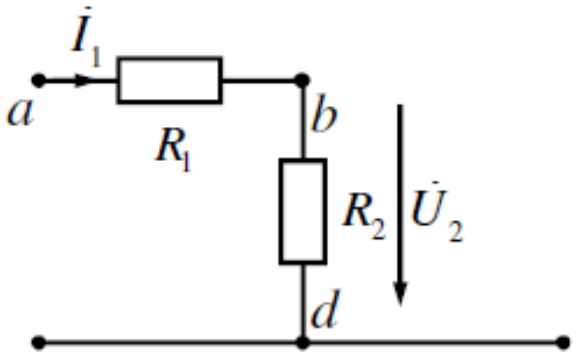
$$\dot{U}_1 = (R_1 + R_2)\dot{I}_1$$

$$\rightarrow Z_{11} = R_1 + R_2 = 10 + 20 = \boxed{30\ \Omega}$$

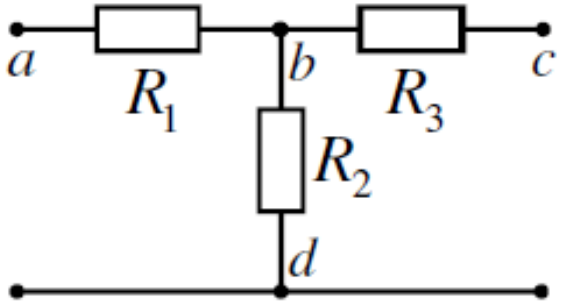
$$\begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2 \end{cases}$$

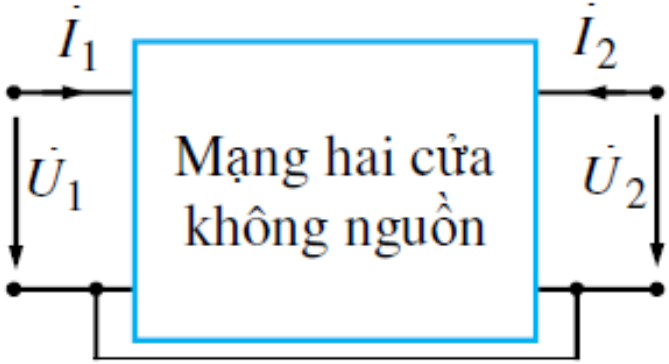
VD1

$R_1 = 10\ \Omega;\ R_2 = 20\ \Omega;\ R_3 = 30\ \Omega;$ Tìm **Z**?



$$\left.\begin{aligned} Z_{21} &= \left.\frac{\dot{U}_2}{\dot{I}_1}\right|_{\dot{I}_2=0} \\ \dot{U}_2 &= R_2\dot{I}_1 \end{aligned}\right\} \rightarrow Z_{21} = R_2 = \boxed{20\ \Omega}$$

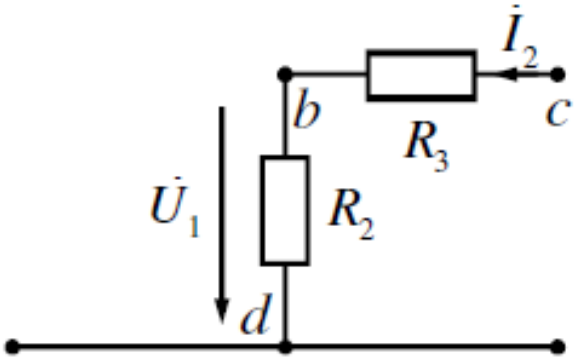




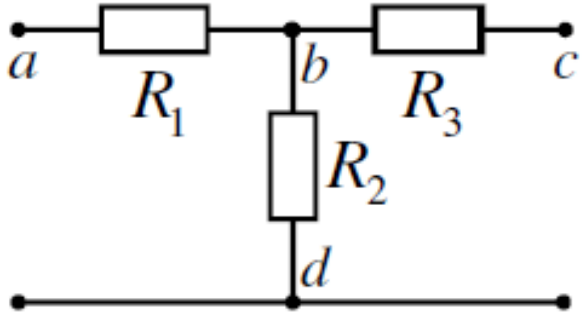
$$\begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2 \end{cases}$$

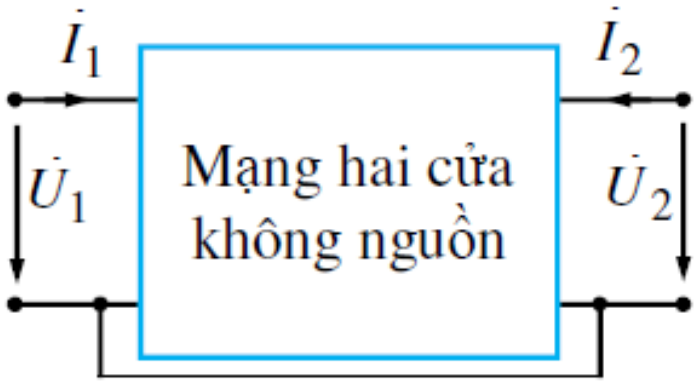
VD1

$R_1 = 10\ \Omega;\ R_2 = 20\ \Omega;\ R_3 = 30\ \Omega;$ Tìm $\mathbf{Z}$?



$$\left.\begin{aligned} Z_{12} &= \left.\frac{\dot{U}_1}{\dot{I}_2}\right|_{\dot{I}_1=0} \\ \dot{U}_1 &= R_2\dot{I}_2 \end{aligned}\right\} \rightarrow Z_{12} = R_2 = \boxed{20\ \Omega}$$

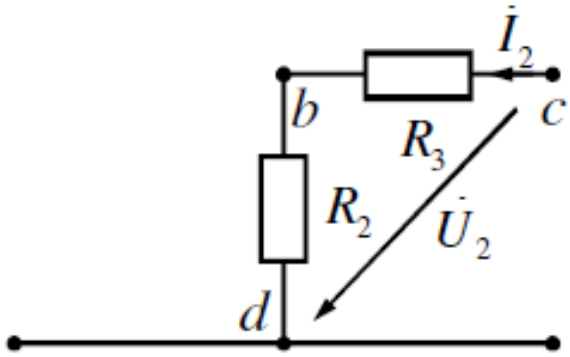


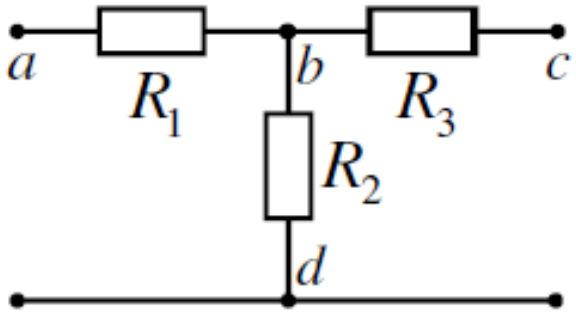


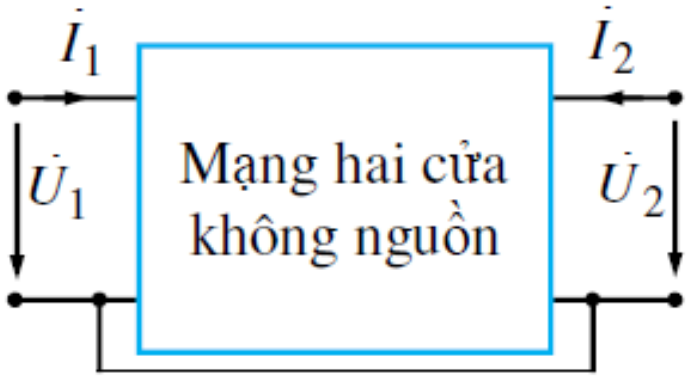
$$\begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2 \end{cases}$$

VD1

$R_1 = 10\ \Omega; R_2 = 20\ \Omega; R_3 = 30\ \Omega$; Tìm **Z**?





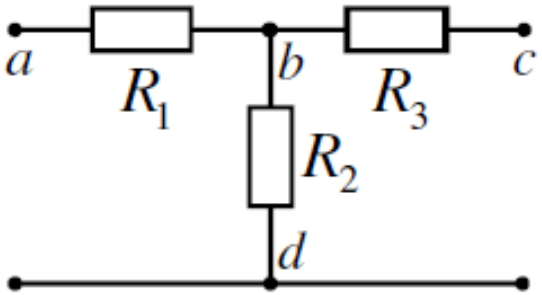


$$\left.\begin{aligned} Z_{22} &= \left.\frac{\dot{U}_2}{\dot{I}_2}\right|_{\dot{I}_1=0} \\ \dot{U}_1 &= (R_2 + R_3)\dot{I}_2 \end{aligned}\right\} \rightarrow Z_{22} = R_2 + R_3 = 20 + 30 = \boxed{50\ \Omega}$$

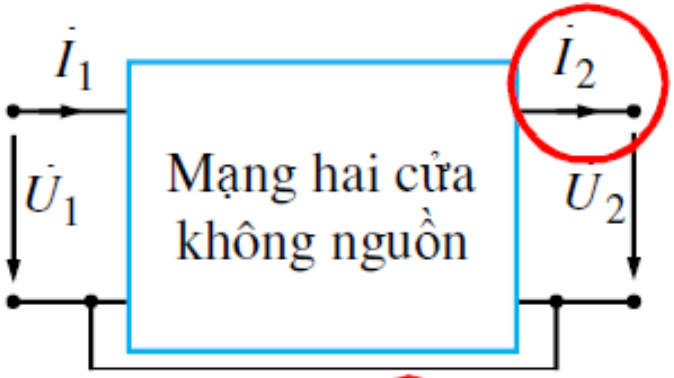
$$\begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2 \end{cases}$$

VD1

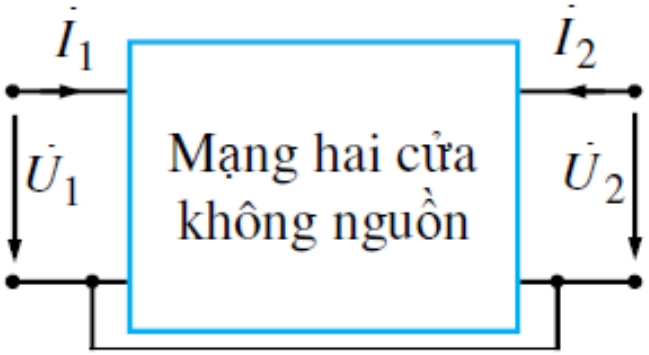
$R_1 = 10\ \Omega;\ R_2 = 20\ \Omega;\ R_3 = 30\ \Omega;$ Tìm **Z**?



Cách 1



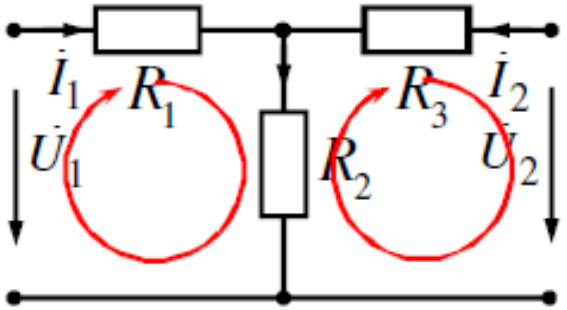
$$\mathbf{Z} = \begin{bmatrix} 30 & -20 \\ 20 & -50 \end{bmatrix} \Omega$$



$$\mathbf{Z} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix} \Omega$$

VD1

$R_1 = 10\ \Omega; R_2 = 20\ \Omega; R_3 = 30\ \Omega$; Tìm **Z**?



Cách 2

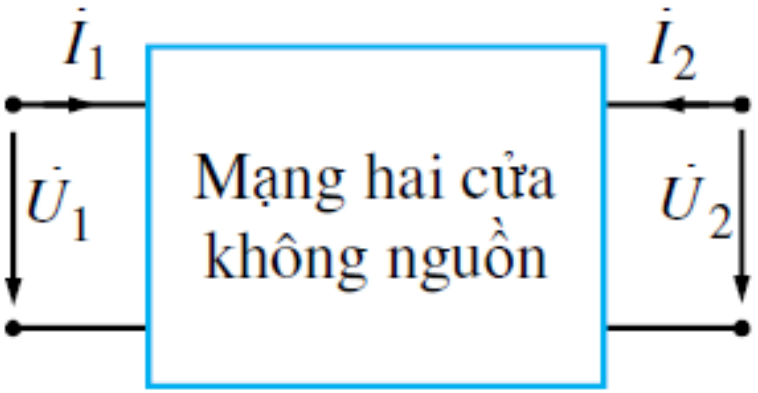
$$\left.\begin{aligned}\dot{U}_1 &= \dot{U}_{R1} + \dot{U}_{R2} = R_1\dot{I}_1 + R_2(\dot{I}_1 + \dot{I}_2) = (R_1 + R_2)\dot{I}_1 + R_2\dot{I}_2\\ \dot{U}_2 &= \dot{U}_{R3} + \dot{U}_{R2} = R_3\dot{I}_2 + R_2(\dot{I}_1 + \dot{I}_2) = R_2\dot{I}_1 + (R_2 + R_3)\dot{I}_2\end{aligned}\right\}$$

$$\rightarrow \begin{cases}\dot{U}_1 = (R_1 + R_2)\dot{I}_1 + R_2\dot{I}_2\\ \dot{U}_2 = R_2\dot{I}_1 + (R_2 + R_3)\dot{I}_2\end{cases}$$

$$\begin{cases}\dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2\\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2\end{cases} \rightarrow \begin{cases}Z_{11} = R_1 + R_2 = 30\Omega\\ Z_{12} = R_2 = 20\Omega\\ Z_{21} = R_2 = 20\Omega\\ Z_{22} = R_2 + R_3 = 50\Omega\end{cases}$$

Bộ thông số **Y** (1)

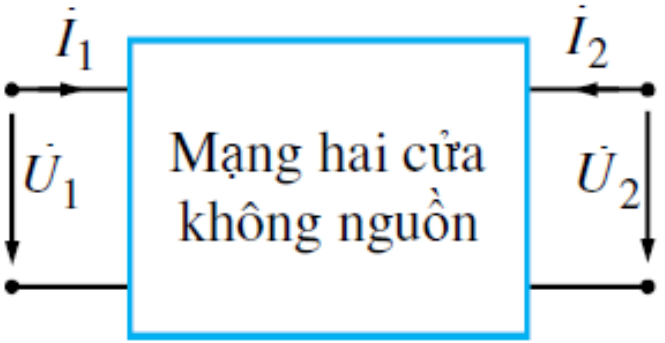
- Gọi là bộ số tổng dẫn.

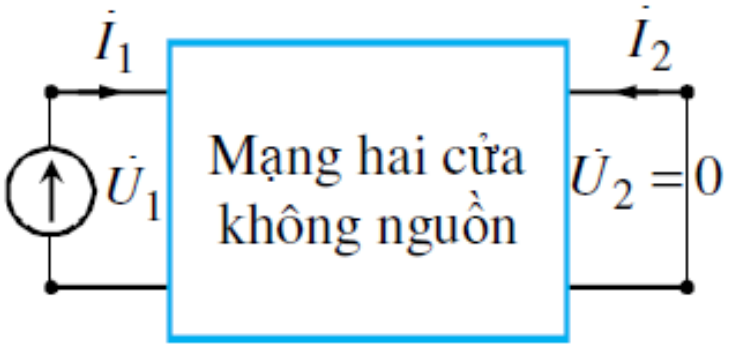


$$\begin{cases} \dot{I}_1 = Y_{11}\dot{U}_1 + Y_{12}\dot{U}_2 \\ \dot{I}_2 = Y_{21}\dot{U}_1 + Y_{22}\dot{U}_2 \end{cases} \leftrightarrow \begin{bmatrix} \dot{I}_1 \\ \dot{I}_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} \dot{U}_1 \\ \dot{U}_2 \end{bmatrix} = [Y] \begin{bmatrix} \dot{U}_1 \\ \dot{U}_2 \end{bmatrix}$$

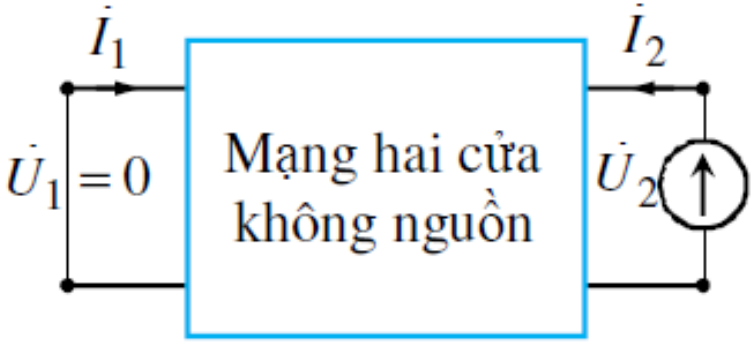
Bộ thông số **Y** (2)

$$\begin{cases} \dot{I}_1 = Y_{11}\dot{U}_1 + Y_{12}\dot{U}_2 \\ \dot{I}_2 = Y_{21}\dot{U}_1 + Y_{22}\dot{U}_2 \end{cases}$$





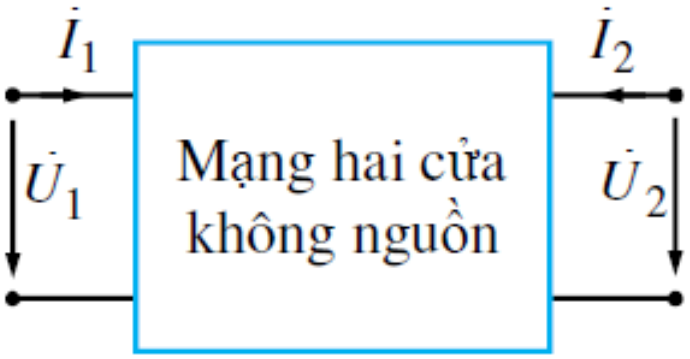
$$\rightarrow Y_{11} = \left.\frac{\dot{I}_1}{\dot{U}_1}\right|_{\dot{U}_2=0}, \quad Y_{21} = \left.\frac{\dot{I}_2}{\dot{U}_1}\right|_{\dot{U}_2=0}$$



$$\rightarrow Y_{12} = \left.\frac{\dot{I}_1}{\dot{U}_2}\right|_{\dot{U}_1=0}, \quad Y_{22} = \left.\frac{\dot{I}_2}{\dot{U}_2}\right|_{\dot{U}_1=0}$$

Bộ thông số **H** (1)

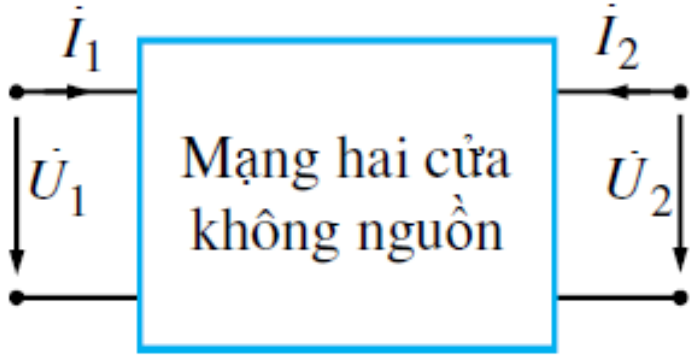
- Còn gọi là bộ số lai (H: hybrid).
- Dùng để mô tả các linh kiện điện tử (ví dụ transistor).

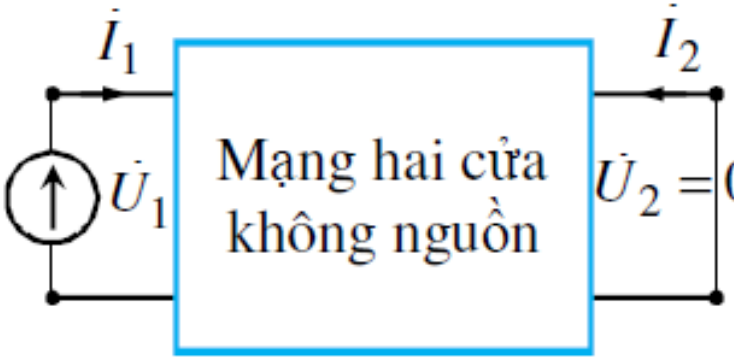


$$\begin{cases} \dot{U}_1 = H_{11}\dot{I}_1 + H_{12}\dot{U}_2 \\ \dot{I}_2 = H_{21}\dot{I}_1 + H_{22}\dot{U}_2 \end{cases} \leftrightarrow \begin{bmatrix} \dot{U}_1 \\ \dot{I}_2 \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{bmatrix} \begin{bmatrix} \dot{I}_1 \\ \dot{U}_2 \end{bmatrix} = [H] \begin{bmatrix} \dot{I}_1 \\ \dot{U}_2 \end{bmatrix}$$

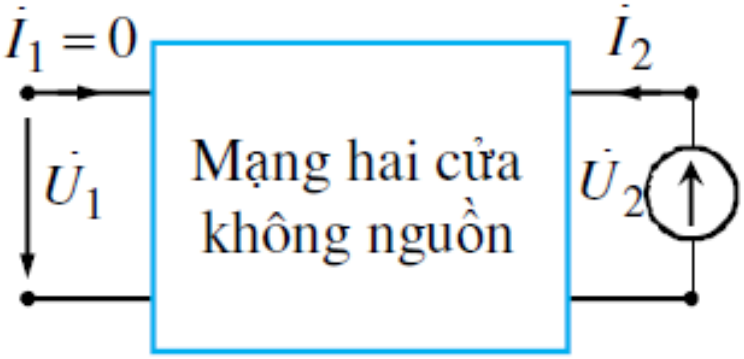
Bộ thông số **H** (2)

$$\begin{cases} \dot{U}_1 = H_{11}\dot{I}_1 + H_{12}\dot{U}_2 \\ \dot{I}_2 = H_{21}\dot{I}_1 + H_{22}\dot{U}_2 \end{cases}$$





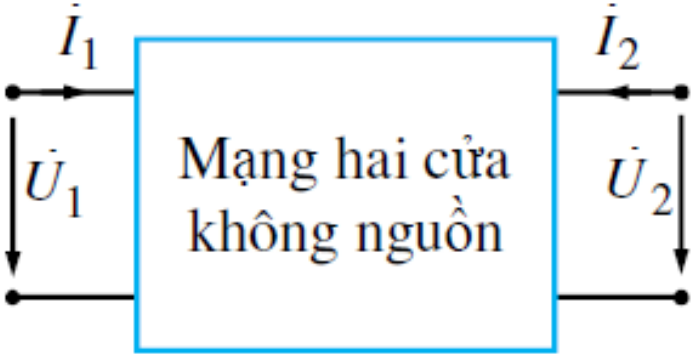
$$\rightarrow H_{11} = \left.\frac{\dot{U}_1}{\dot{I}_1}\right|_{\dot{U}_2=0}, \quad H_{21} = \left.\frac{\dot{I}_2}{\dot{I}_1}\right|_{\dot{U}_2=0}$$



$$\rightarrow H_{12} = \left.\frac{\dot{U}_1}{\dot{U}_2}\right|_{\dot{I}_1=0}, \quad H_{22} = \left.\frac{\dot{I}_2}{\dot{U}_2}\right|_{\dot{I}_1=0}$$

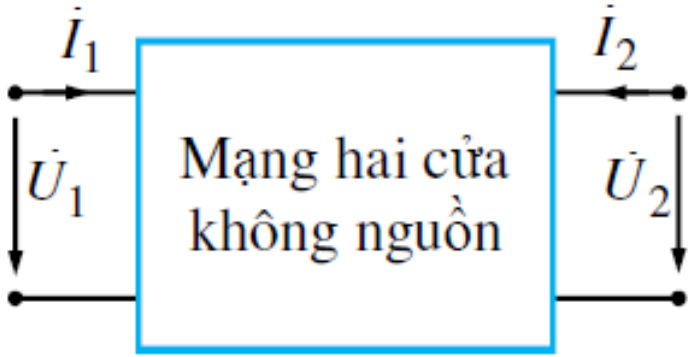
Bộ thông số **G** (1)

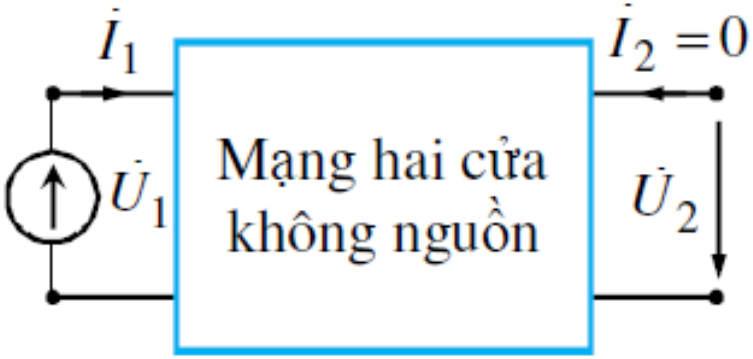
- Còn gọi là bộ số lai nghịch đảo.



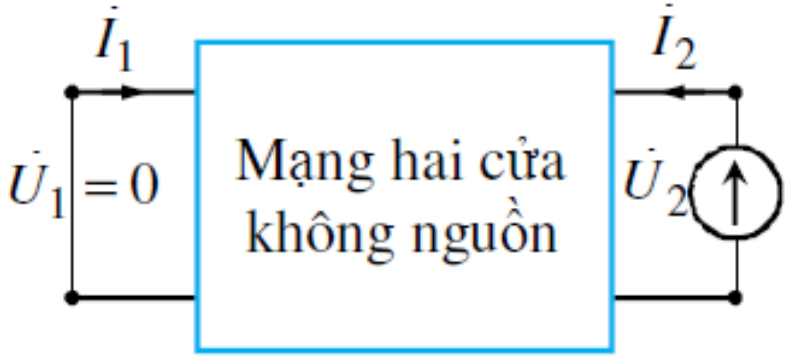
$$\begin{cases} \dot{I}_1 = G_{11}\dot{U}_1 + G_{12}\dot{I}_2 \\ \dot{U}_2 = G_{21}\dot{U}_1 + G_{22}\dot{I}_2 \end{cases} \leftrightarrow \begin{bmatrix} \dot{I}_1 \\ \dot{U}_2 \end{bmatrix} = \begin{bmatrix} G_{11} & G_{12} \\ G_{21} & G_{22} \end{bmatrix} \begin{bmatrix} \dot{U}_1 \\ \dot{I}_2 \end{bmatrix} = [G] \begin{bmatrix} \dot{U}_1 \\ \dot{I}_2 \end{bmatrix}$$

$$\begin{cases} \dot{I}_1 = G_{11}\dot{U}_1 + G_{12}\dot{I}_2 \\ \dot{U}_2 = G_{21}\dot{U}_1 + G_{22}\dot{I}_2 \end{cases}$$





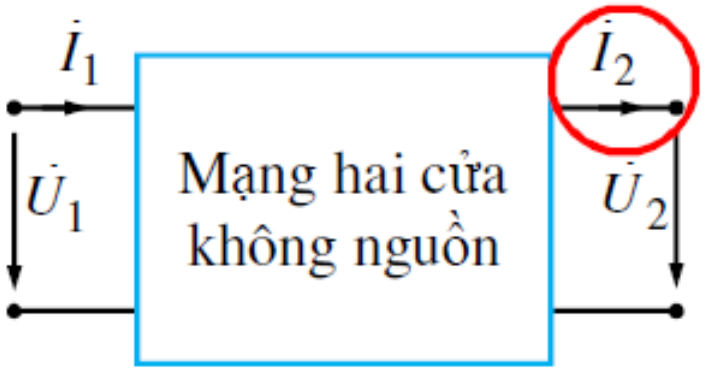
$$\rightarrow G_{11} = \left.\frac{\dot{I}_1}{\dot{U}_1}\right|_{\dot{I}_2=0}, \quad G_{21} = \left.\frac{\dot{U}_2}{\dot{U}_1}\right|_{\dot{I}_2=0}$$



$$\rightarrow G_{12} = \left.\frac{\dot{I}_1}{\dot{I}_2}\right|_{\dot{U}_1=0}, \quad G_{22} = \left.\frac{\dot{U}_2}{\dot{I}_2}\right|_{\dot{U}_1=0}$$

Bộ thông số **A** (1)

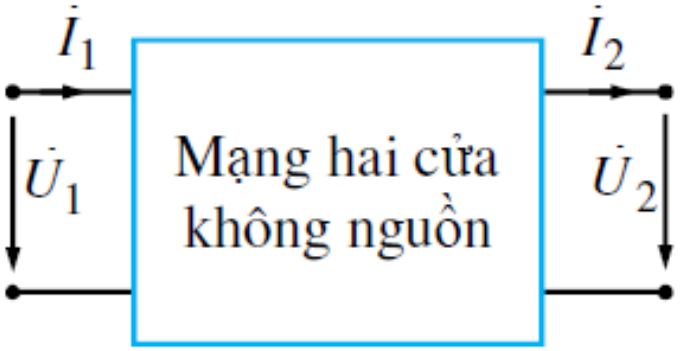
- Còn gọi là bộ số truyền tải.
- Ký hiệu khác: T(ransmission).
- Thường được dùng trong phân tích đường dây truyền tải (hệ thống điện, hệ thống liên lạc).

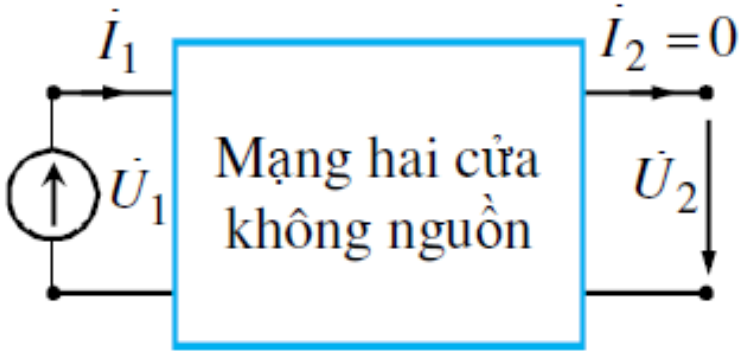


$$\begin{cases} \dot{U}_1 = A_{11}\dot{U}_2 + A_{12}\dot{I}_2 \\ \dot{I}_1 = A_{21}\dot{U}_2 + A_{22}\dot{I}_2 \end{cases} \leftrightarrow \begin{bmatrix} \dot{U}_1 \\ \dot{I}_1 \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \begin{bmatrix} \dot{U}_2 \\ \dot{I}_2 \end{bmatrix} = [A] \begin{bmatrix} \dot{U}_2 \\ \dot{I}_2 \end{bmatrix}$$

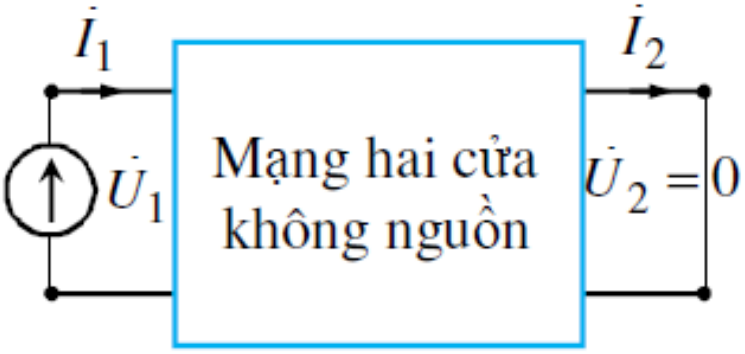
Bộ thông số A

$$\begin{cases} \dot{U}_1 = A_{11}\dot{U}_2 + A_{12}\dot{I}_2 \\ \dot{I}_1 = A_{21}\dot{U}_2 + A_{22}\dot{I}_2 \end{cases}$$





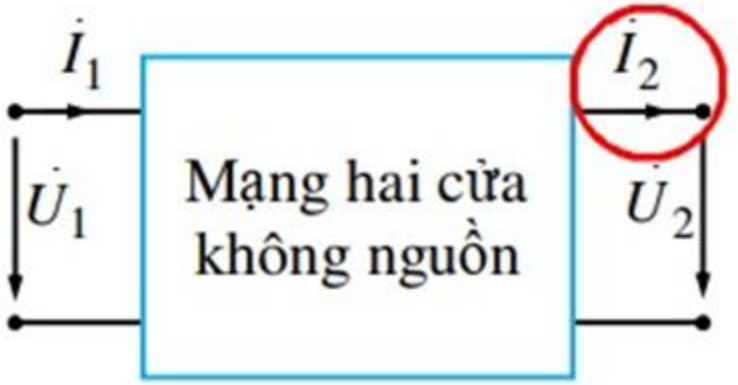
$$\rightarrow A_{11} = \left.\frac{\dot{U}_1}{\dot{U}_2}\right|_{\dot{I}_2=0}, \quad A_{21} = \left.\frac{\dot{I}_1}{\dot{U}_2}\right|_{\dot{I}_2=0}$$



$$\rightarrow A_{12} = \left.\frac{\dot{U}_1}{\dot{I}_2}\right|_{\dot{U}_2=0}, \quad A_{22} = \left.\frac{\dot{I}_1}{\dot{I}_2}\right|_{\dot{U}_2=0}$$

Bộ thông số B

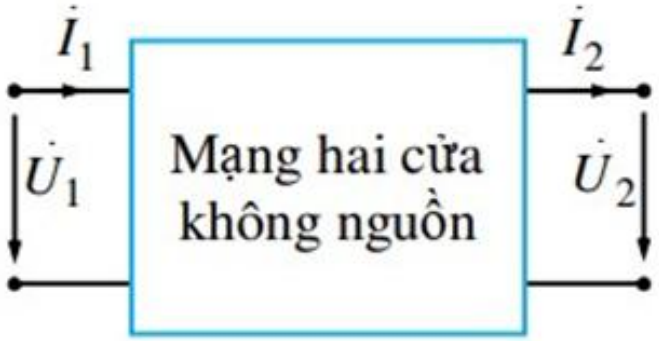
- Còn gọi là bộ số truyền tải ngược.
- Ký hiệu khác: t(ransmission).

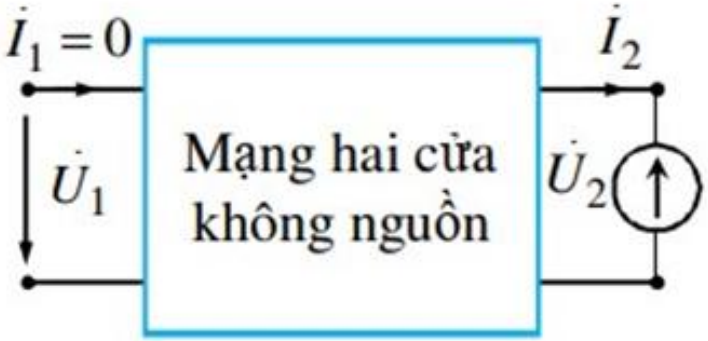


$$\begin{cases} \dot{U}_2 = B_{11}\dot{U}_1 + B_{12}\dot{I}_1 \\ \dot{I}_2 = B_{21}\dot{U}_1 + B_{22}\dot{I}_1 \end{cases} \leftrightarrow \begin{bmatrix} \dot{U}_2 \\ \dot{I}_2 \end{bmatrix} = \begin{bmatrix} B_{11} & B_{12} \\ B_{21} & B_{22} \end{bmatrix} \begin{bmatrix} \dot{U}_1 \\ \dot{I}_1 \end{bmatrix} = [B] \begin{bmatrix} \dot{U}_1 \\ \dot{I}_1 \end{bmatrix}$$

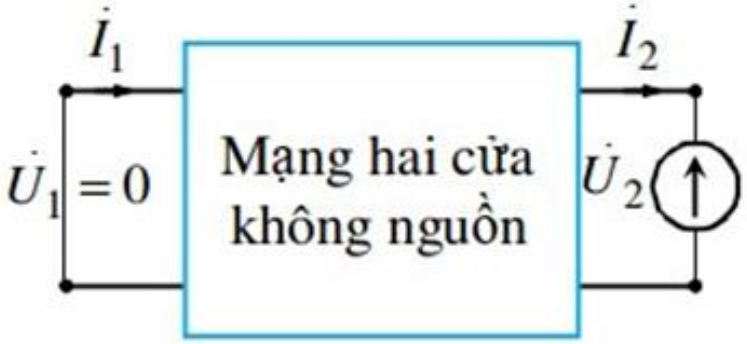
Bộ thông số B

$$\begin{cases} \dot{U}_2 = B_{11}\dot{U}_1 + B_{12}\dot{I}_1 \\ \dot{I}_2 = B_{21}\dot{U}_1 + B_{22}\dot{I}_1 \end{cases}$$



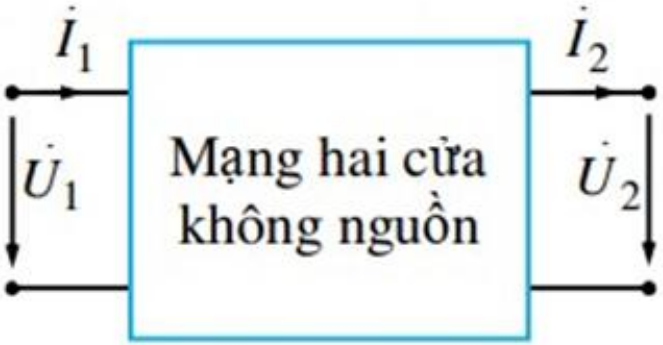


$$\rightarrow B_{11} = \left.\frac{\dot{U}_2}{\dot{U}_1}\right|_{\dot{I}_1=0}, \quad B_{21} = \left.\frac{\dot{I}_2}{\dot{U}_1}\right|_{\dot{I}_1=0}$$



$$\rightarrow B_{12} = \left.\frac{\dot{U}_2}{\dot{I}_1}\right|_{\dot{U}_1=0}, \quad B_{22} = \left.\frac{\dot{I}_2}{\dot{I}_1}\right|_{\dot{U}_1=0}$$

2.3. Quan hệ giữa các bộ thông số



$$\begin{bmatrix}\dot{U}_1\\ \dot{U}_2\end{bmatrix}=\begin{bmatrix}Z_{11} & Z_{12}\\ Z_{21} & Z_{22}\end{bmatrix}\begin{bmatrix}\dot{I}_1\\ \dot{I}_2\end{bmatrix}=[Z]\begin{bmatrix}\dot{I}_1\\ \dot{I}_2\end{bmatrix}$$

$$\rightarrow \begin{bmatrix}\dot{I}_1\\ \dot{I}_2\end{bmatrix}=[Z]^{-1}\begin{bmatrix}\dot{U}_1\\ \dot{U}_2\end{bmatrix}$$

$$\begin{bmatrix}\dot{I}_1\\ \dot{I}_2\end{bmatrix}=\begin{bmatrix}Y_{11} & Y_{12}\\ Y_{21} & Y_{22}\end{bmatrix}\begin{bmatrix}\dot{U}_1\\ \dot{U}_2\end{bmatrix}=[Y]\begin{bmatrix}\dot{U}_1\\ \dot{U}_2\end{bmatrix}$$

$$\rightarrow \boxed{[Y]=[Z]^{-1}}$$

$$\boxed{[G]=[H]^{-1}}$$

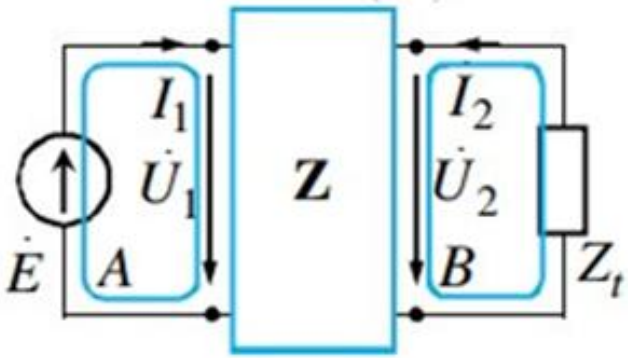
$$\left.\begin{aligned}&\left.\begin{cases}\dot{U}_1 = H_{11}\dot{I}_1 + H_{12}\dot{U}_2 \\ \dot{I}_2 = H_{21}\dot{I}_1 + H_{22}\dot{U}_2 \rightarrow \dot{U}_2 = -\dfrac{H_{12}}{H_{22}}\dot{I}_1 + \dfrac{1}{H_{22}}\dot{I}_2\end{cases}\right\} \\ &\rightarrow \dot{U}_1 = \left(H_{11} - \frac{H_{12}H_{21}}{H_{22}}\right)\dot{I}_1 + \frac{H_{12}}{H_{22}}\dot{I}_2\end{aligned}\right\}$$

$$\rightarrow \begin{cases}\dot{U}_1 = \left(H_{11} - \dfrac{H_{12}H_{21}}{H_{22}}\right)\dot{I}_1 + \dfrac{H_{12}}{H_{22}}\dot{I}_2 \\ \dot{U}_2 = -\dfrac{H_{12}}{H_{21}}\dot{I}_1 + \dfrac{1}{H_{22}}\dot{I}_2\end{cases} \quad \rightarrow \mathbf{Z} = \begin{bmatrix} H_{11} - \dfrac{H_{12}H_{21}}{H_{22}} & \dfrac{H_{12}}{H_{22}} \\ -\dfrac{H_{12}}{H_{22}} & \dfrac{1}{H_{22}}\end{bmatrix}$$

VD1

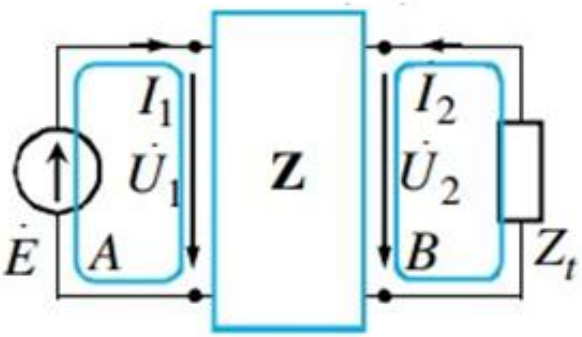
$\dot{E} = 220\,\text{V};\ Z_t = j50\ \Omega;\ \mathbf{Z} = \begin{bmatrix} 10 & j20 \\ j20 & 40 \end{bmatrix}\ \Omega.$

1. Viết hệ phương trình bộ số,
2. Viết phương trình dòng/áp/…,
3. Giải hệ phương trình.



VD1

$\dot{E} = 220\,\text{V};\ Z_t = j50\ \Omega;\ \mathbf{Z} = \begin{bmatrix} 10 & j20 \\ j20 & 40 \end{bmatrix}\ \Omega.$



1. Viết hệ phương trình bộ số,
2. Viết phương trình dòng/áp/…,
3. Giải hệ phương trình.

$$\begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2 \end{cases}$$

$$\mathbf{Z} = \begin{bmatrix} 10 & j20 \\ j20 & 40 \end{bmatrix}$$

$$\rightarrow \begin{cases} \dot{U}_1 = 10\dot{I}_1 + j20\dot{I}_2 \\ \dot{U}_2 = j20\dot{I}_1 + 40\dot{I}_2 \\ A:\ \dot{U}_1 = \dot{E} \\ B:\ Z_t\dot{I}_2 + \dot{U}_2 = 0 \end{cases} \rightarrow \begin{cases} 220\angle 0^0 = 10\dot{I}_1 + j20\dot{I}_2 \\ -j50\dot{I}_2 = j20\dot{I}_1 + 40\dot{I}_2 \end{cases}$$

$$\rightarrow \begin{cases} \boxed{\dot{I}_1 = 14{,}09 + j4{,}94\ \text{A}} \\ \boxed{\dot{I}_2 = -2{,}47 - j3{,}96\ \text{A}} \end{cases}$$

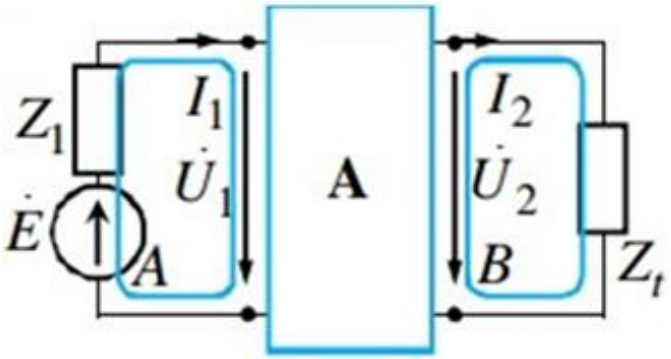
VD2

$\dot{E} = 220\,\text{V};$

$Z_1 = 20\,\Omega;\ Z_t = j50\ \Omega;$

$$\mathbf{A} = \begin{bmatrix} 3 & 200 \\ 0,04 & 3 \end{bmatrix}.$$

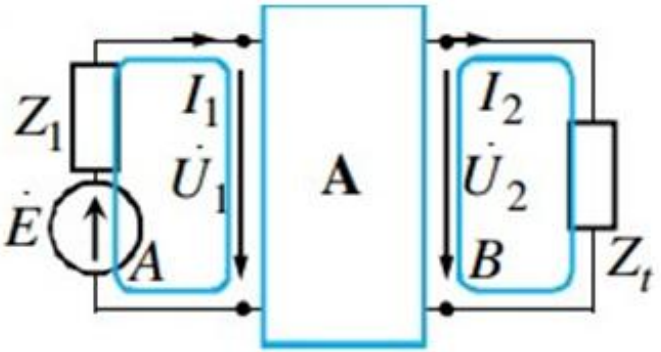
1. Viết hệ phương trình bộ số,
2. Viết phương trình dòng/áp/…,
3. Giải hệ phương trình.



VD2

$\dot{E} = 220\,\text{V};$ $\quad \mathbf{A} = \begin{bmatrix} 3 & 200 \\ 0,04 & 3 \end{bmatrix}.$

$Z_1 = 20\,\Omega;\ Z_t = j50\ \Omega;$



1. Viết hệ phương trình bộ số,
2. Viết phương trình dòng/áp/…,
3. Giải hệ phương trình.

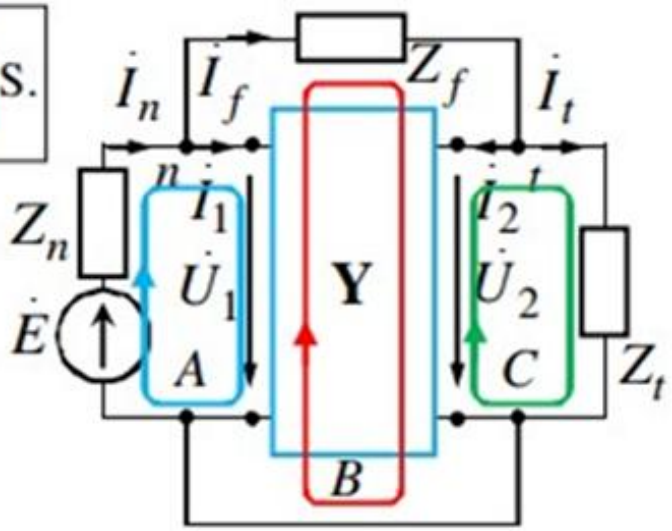
$$\begin{cases} \dot{U}_1 = A_{11}\dot{U}_2 + A_{12}\dot{I}_2 \\ \dot{I}_1 = A_{21}\dot{U}_2 + A_{22}\dot{I}_2 \end{cases}$$

$$\mathbf{A} = \begin{bmatrix} 3 & 200 \\ 0,04 & 3 \end{bmatrix}$$

$$\rightarrow \begin{cases} \dot{U}_1 = 3\dot{U}_2 + 200\dot{I}_2 \\ \dot{I}_1 = 0,04\dot{U}_2 + 3\dot{I}_2 \\ A:\ 20\dot{I}_1 + \dot{U}_1 = 220 \\ B:\ j50\dot{I}_2 - \dot{U}_2 = 0 \end{cases} \rightarrow \begin{cases} \dot{I}_1 = 2,46 - j0,11\ \text{A} \\ \dot{I}_2 = 0,55 - j0,40\ \text{A} \end{cases}$$

VD3

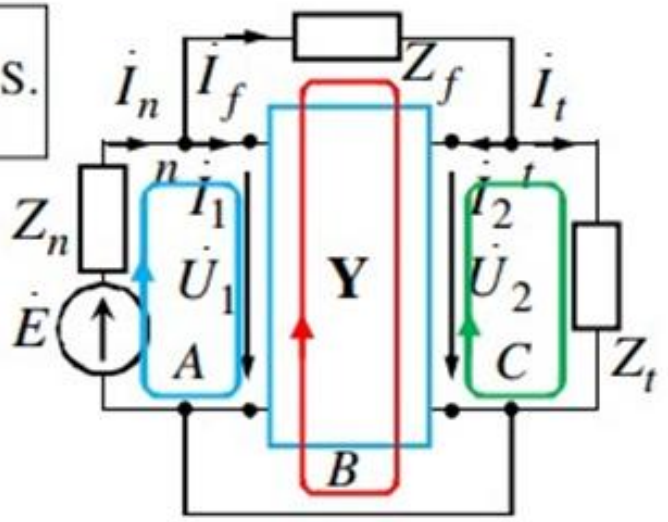
$$\dot{E} = 200\,\text{V};\ Z_n = 5\ \Omega;\quad Z_f = j10\ \Omega;\ Z_t = -j20\ \Omega;\quad \mathbf{Y} = \begin{bmatrix} 0{,}0455 & -0{,}0182 \\ -0{,}0182 & 0{,}0273 \end{bmatrix}\ \text{S}.$$



VD3

$\dot{E} = 200\,\text{V};\ Z_n = 5\ \Omega;$
$Z_f = j10\ \Omega;\ Z_t = -j20\ \Omega;$
$\mathbf{Y} = \begin{bmatrix} 0,0455 & -0,0182 \\ -0,0182 & 0,0273 \end{bmatrix}$ S.

Cách 1

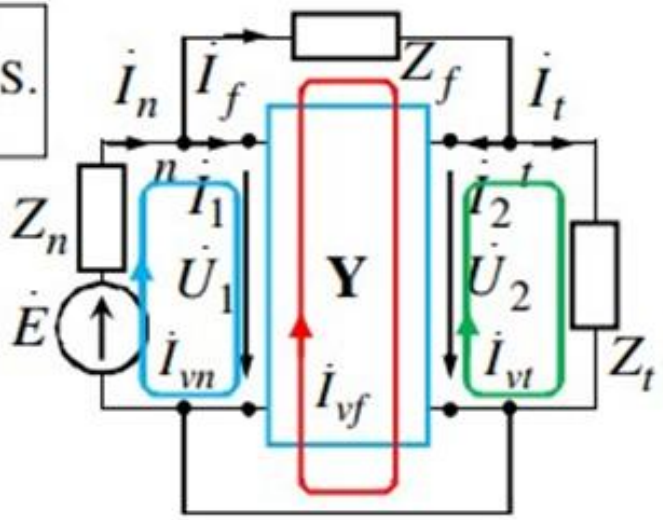


$$\begin{cases} \begin{cases} \dot{I}_1 = Y_{11}\dot{U}_1 + Y_{12}\dot{U}_2 \\ \dot{I}_2 = Y_{21}\dot{U}_1 + Y_{22}\dot{U}_2 \end{cases} \\ n:\ \dot{I}_n - \dot{I}_1 - \dot{I}_f = 0 \\ t:\ \dot{I}_f - \dot{I}_2 - \dot{I}_t = 0 \\ A:\ Z_n\dot{I}_n + \dot{U}_1 = \dot{E} \\ B:\ Z_f\dot{I}_f - \dot{U}_1 + \dot{U}_2 = 0 \\ C:\ \dot{U}_2 - Z_t\dot{I}_t = 0 \end{cases}$$

$$\rightarrow \begin{cases} \dot{I}_n = 12,80 + j7,99\ \text{A} \\ \dot{I}_t = 7,20 + j10,40\ \text{A} \end{cases}$$

VD3

$$\dot{E} = 200\,\text{V};\ Z_n = 5\ \Omega;\quad Z_f = j10\ \Omega;\ Z_t = -j20\ \Omega;\quad \mathbf{Y} = \begin{bmatrix} 0,0455 & -0,0182 \\ -0,0182 & 0,0273 \end{bmatrix}\text{S}.$$



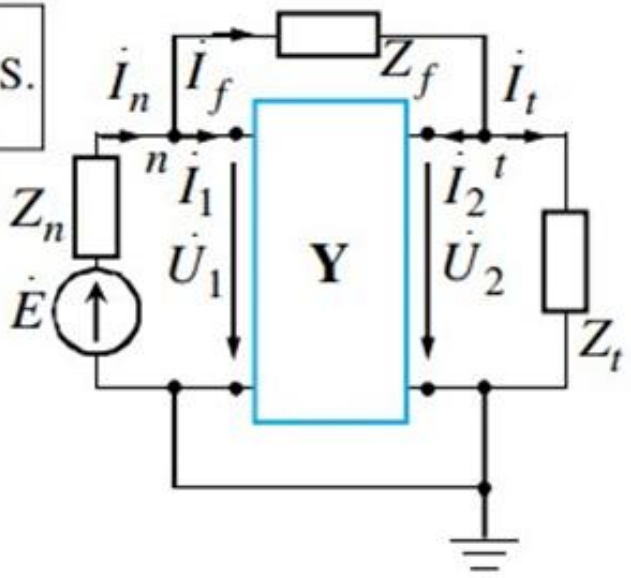
Cách 2

$$\begin{cases} \begin{cases} \dot{I}_1 = Y_{11}\dot{U}_1 + Y_{12}\dot{U}_2 = \dot{I}_{vn} - \dot{I}_{vf} \\ \dot{I}_2 = Y_{21}\dot{U}_1 + Y_{22}\dot{U}_2 = \dot{I}_{vf} - \dot{I}_{vt} \end{cases} \\ Z_n\dot{I}_{vn} + \dot{U}_1 = \dot{E} \\ \dot{U}_2 - Z_t\dot{I}_{vt} = 0 \\ Z_f\dot{I}_{vf} - \dot{U}_1 + \dot{U}_2 = 0 \end{cases}$$

$$\rightarrow \begin{cases} \dot{I}_{vn} = 12,80 + j7,99\ \text{A} \\ \dot{I}_{vt} = 7,20 + j10,40\ \text{A} \end{cases} \quad \rightarrow \begin{cases} \dot{I}_n = 12,80 + j7,99\ \text{A} \\ \dot{I}_t = 7,20 + j10,40\ \text{A} \end{cases}$$

VD3

$$\dot{E} = 200\,\text{V};\ Z_n = 5\ \Omega;\quad Z_f = j10\ \Omega;\ Z_t = -j20\ \Omega;\quad \mathbf{Y} = \begin{bmatrix} 0,0455 & -0,0182 \\ -0,0182 & 0,0273 \end{bmatrix} \text{S}.$$



Cách 3

$$n: \dot{I}_n - \dot{I}_1 - \dot{I}_f = 0$$

$$t: \dot{I}_f - \dot{I}_2 - \dot{I}_t = 0$$

$$\begin{cases} \dot{I}_1 = Y_{11}\dot{U}_1 + Y_{12}\dot{U}_2 = Y_{11}\dot{\varphi}_n + Y_{12}\dot{\varphi}_t \\ \dot{I}_2 = Y_{21}\dot{U}_1 + Y_{22}\dot{U}_2 = Y_{21}\dot{\varphi}_n + Y_{22}\dot{\varphi}_t \end{cases}$$

$$\dot{I}_n = \frac{\dot{E} - \dot{\varphi}_n}{Z_n}$$

$$\dot{I}_t = \frac{\dot{\varphi}_t}{Z_t}$$

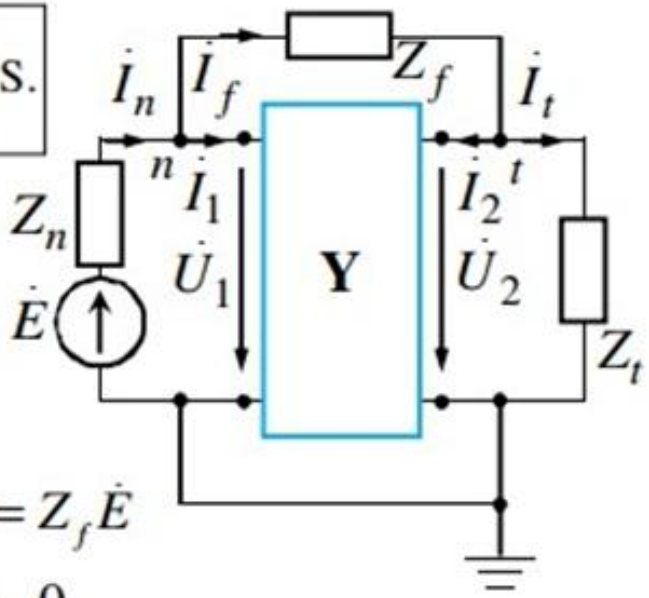
$$\dot{I}_f = \frac{\dot{\varphi}_n - \dot{\varphi}_t}{Z_f}$$

$$\rightarrow \begin{cases} (Z_n Z_f Y_{11} + Z_n + Z_f)\dot{\varphi}_n + (Z_n Z_f Y_{12} - Z_n)\dot{\varphi}_t = Z_f \dot{E} \\ (Z_t Z_f Y_{21} - Z_t)\dot{\varphi}_n + (Z_t Z_f Y_{22} + Z_t + Z_f)\dot{\varphi}_t = 0 \end{cases}$$

VD3

$\dot{E} = 200\,\text{V};\ Z_n = 5\ \Omega;$
$Z_f = j10\ \Omega;\ Z_t = -j20\ \Omega;$
$\mathbf{Y} = \begin{bmatrix} 0,0455 & -0,0182 \\ -0,0182 & 0,0273 \end{bmatrix}$ S.

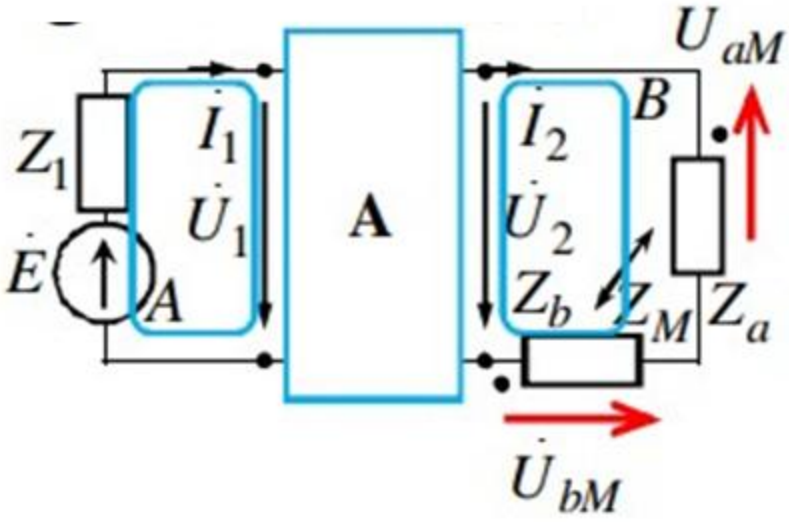
Cách 3



$$\begin{cases} (Z_n Z_f Y_{11} + Z_n + Z_f)\dot{\varphi}_n + (Z_n Z_f Y_{12} - Z_n)\dot{\varphi}_t = Z_f \dot{E} \\ (Z_t Z_f Y_{21} - Z_t)\dot{\varphi}_n + (Z_t Z_f Y_{22} + Z_t + Z_f)\dot{\varphi}_t = 0 \end{cases}$$

$$\rightarrow \begin{cases} \dot{\varphi}_n = 135,99 - j39,97\ \text{V} \\ \dot{\varphi}_t = 207,92 - j143,97\ \text{V} \end{cases} \rightarrow \begin{cases} \dot{I}_n = \dfrac{\dot{E} - \dot{\varphi}_n}{Z_n} = 12,80 + j7,99\ \text{A} \\ \dot{I}_t = \dfrac{\dot{\varphi}_t}{Z_t} = 7,20 + j10,40\ \text{A} \end{cases}$$

VD4



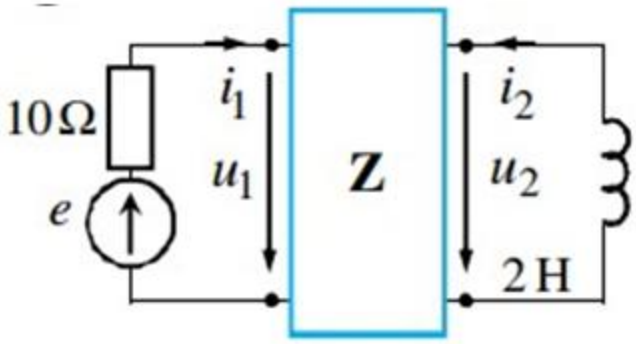
$$\begin{cases} \begin{cases} \dot{U}_1 = A_{11}\dot{U}_2 + A_{12}\dot{I}_2 \\ \dot{I}_1 = A_{21}\dot{U}_2 + A_{22}\dot{I}_2 \end{cases} \\ Z_1\dot{I}_1 + \dot{U}_1 = \dot{E} \\ \dot{U}_2 = (Z_a + Z_b - 2Z_M)\dot{I}_2 \end{cases}$$

$$\dot{U}_{aM} = Z_M\dot{I}_2$$

$$\dot{U}_{bM} = Z_M\dot{I}_2$$

VD5

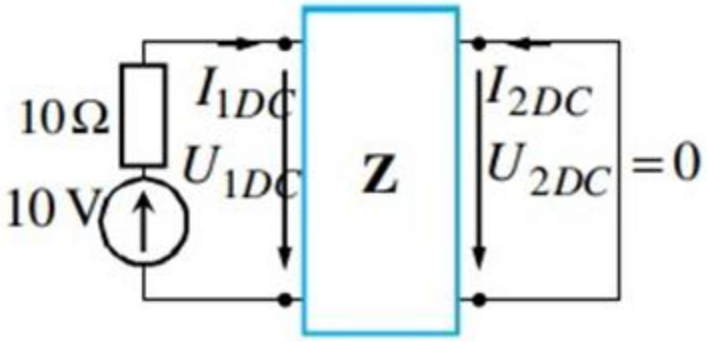
$e = 10 + 20\cos 5t$ V; $\mathbf{Z} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix}$ Ω; $i_1 = ?$



Xét nguồn một chiều:

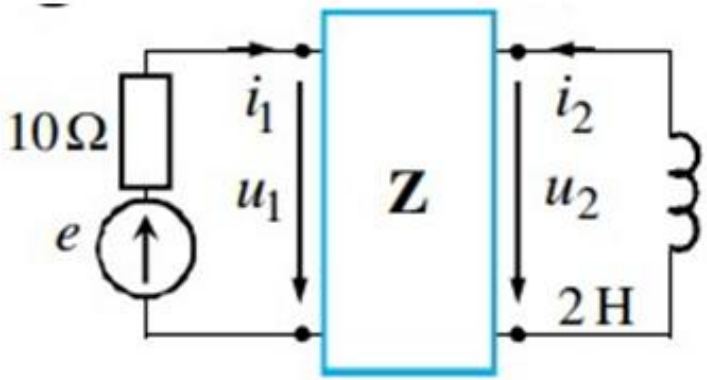
$$\begin{cases} \begin{cases} U_{1DC} = 30I_{1DC} + 20I_{2DC} \\ U_{2DC} = 20I_{1DC} + 50I_{2DC} \end{cases} \\ 10I_{1DC} + U_{1DC} = 10 \\ U_{2DC} = 0 \end{cases}$$

$$\rightarrow I_{1DC} = 0,31\,\text{A}$$



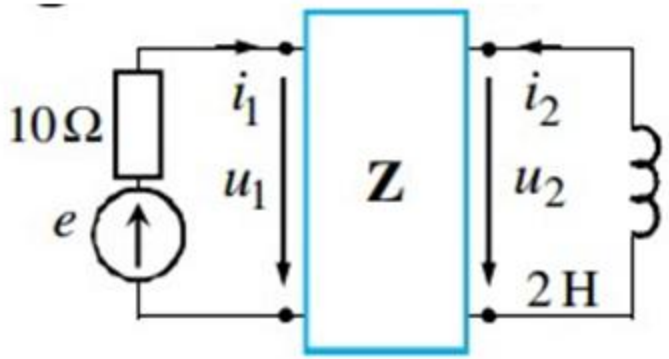
VD5

$$e = 10 + 20\cos 5t \text{ V};\ \mathbf{Z} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix} \Omega;\ i_1 = ?$$



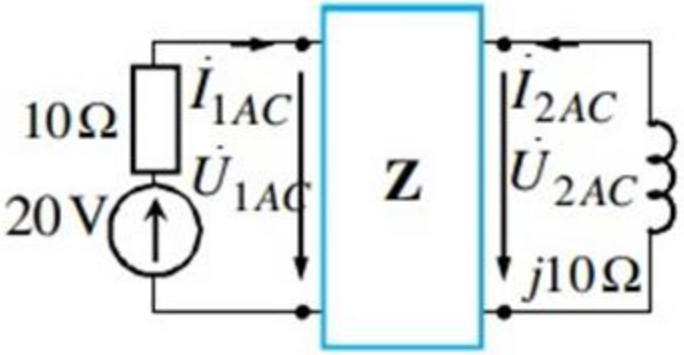
VD5

$e = 10 + 20\cos 5t$ V; $\mathbf{Z} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix}$ Ω; $i_1 = ?$



Xét nguồn xoay chiều:

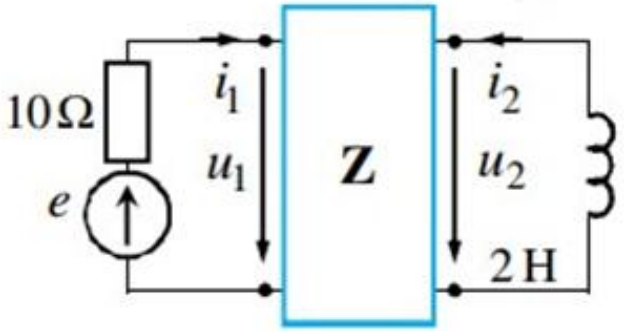
$$\begin{cases} \begin{cases} \dot{U}_{1AC} = 30\dot{I}_{1AC} + 20\dot{I}_{2AC} \\ \dot{U}_{2AC} = 20\dot{I}_{1AC} + 50\dot{I}_{2AC} \end{cases} \\ 10\dot{I}_{1AC} + \dot{U}_{1AC} = 20 \\ \dot{U}_{2AC} + j20\dot{I}_{2AC} = 0 \end{cases}$$

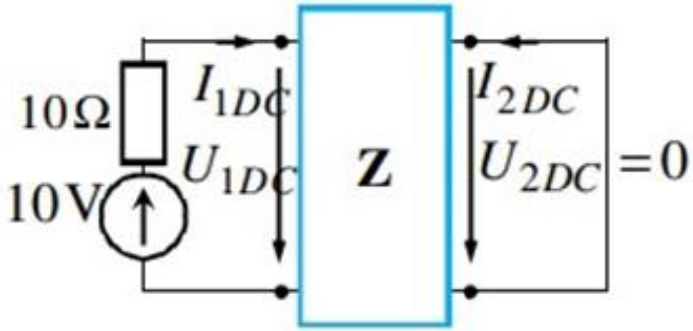


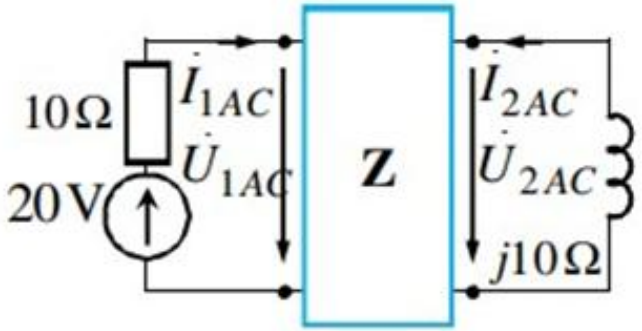
$$\rightarrow \dot{I}_{1AC} = 0,60\angle -4,76^\circ \rightarrow i_{1AC}(t) = 0,60\cos(5t - 4,76^\circ)\ \text{A}$$

VD5

$e = 10 + 20\cos 5t$ V; $\mathbf{Z} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix}$ Ω; $i_1 = ?$







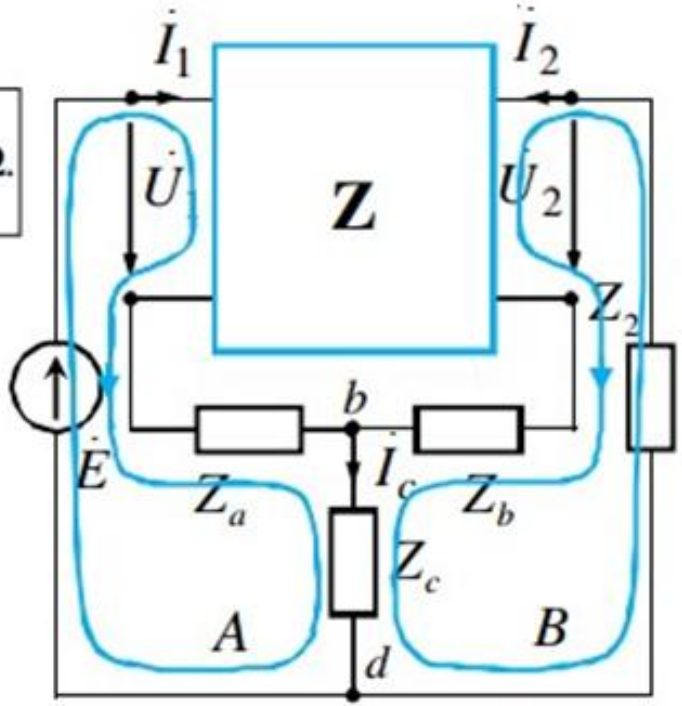
$I_{1DC} = 0,31$ A

$i_{1AC}(t) = 0,60\cos(5t - 4,76^\circ)$ A

$$\rightarrow \boxed{i_1(t) = 0,31 + 0,60\cos(5t - 4,76^\circ)\text{ A}}$$

VD6

$$\dot{E} = 220\,\text{V};\ Z_2 = j10\ \Omega;\quad Z_a = j20\ \Omega;\ Z_b = -j40\ \Omega;\ Z_c = 5\ \Omega;\quad \mathbf{Z} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix}\ \Omega.$$



Cách 1

$$\begin{cases} \begin{cases} \dot{U}_1 = 30\dot{I}_1 + 20\dot{I}_2 \\ \dot{U}_2 = 20\dot{I}_1 + 50\dot{I}_2 \end{cases} \\ b:\ \dot{I}_1 + \dot{I}_2 - \dot{I}_c = 0 \\ A:\ \dot{U}_1 + Z_a\dot{I}_1 + Z_c\dot{I}_c = \dot{E} \\ B:\ Z_2\dot{I}_2 + \dot{U}_2 + Z_b\dot{I}_2 + Z_c\dot{I}_c = 0 \end{cases}$$

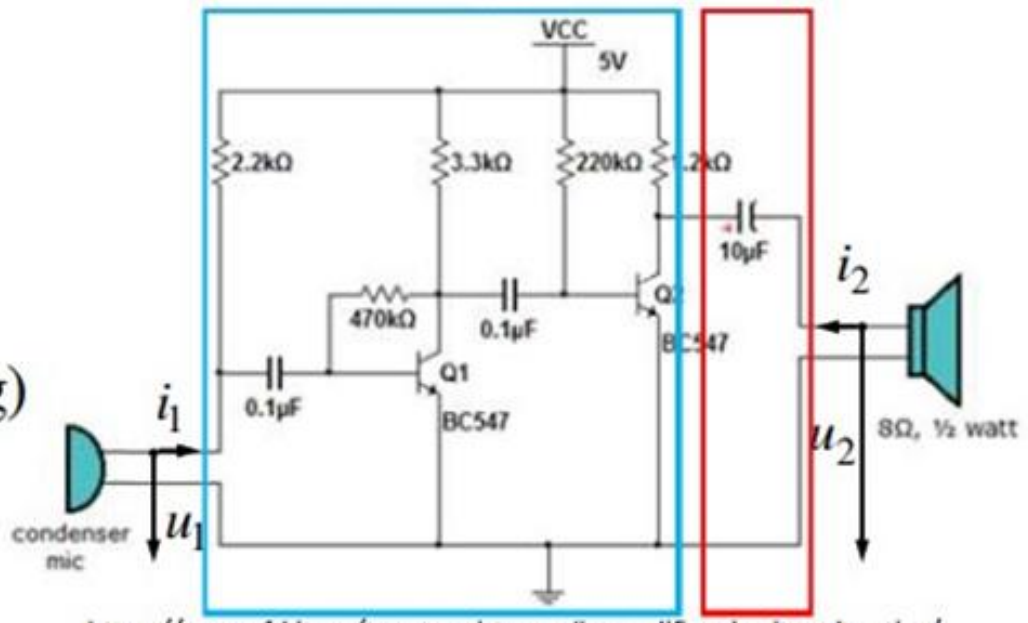
$$\rightarrow \begin{cases} \dot{I}_1 = 6,27 - j3,64\ \text{A} \\ \dot{I}_2 = -2,89 + j0,076\ \text{A} \\ \dot{I}_c = 3,38 - j3,56\ \text{A} \end{cases}$$

Cách 2?

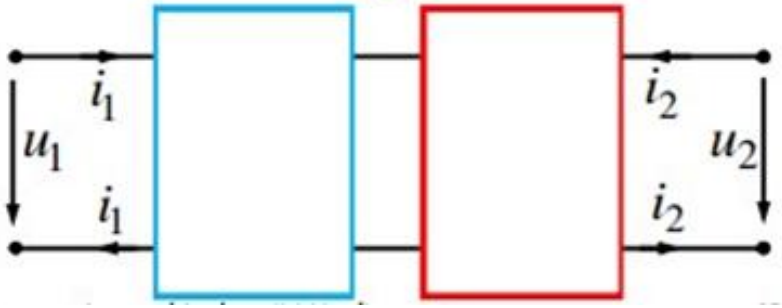
Kết nối các mạng hai cửa

2.4. Kết nối mạng 2 cửa: Nối tiếp

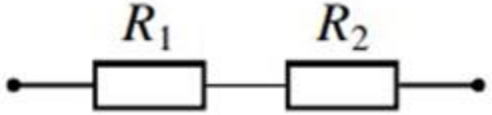
1. Nối tiếp
2. Song song
3. Xâu chuỗi (tầng)
4. Lai 1
5. Lai 2



https://www.efxkits.us/two-transistor-audio-amplifier-circuit-explanation/

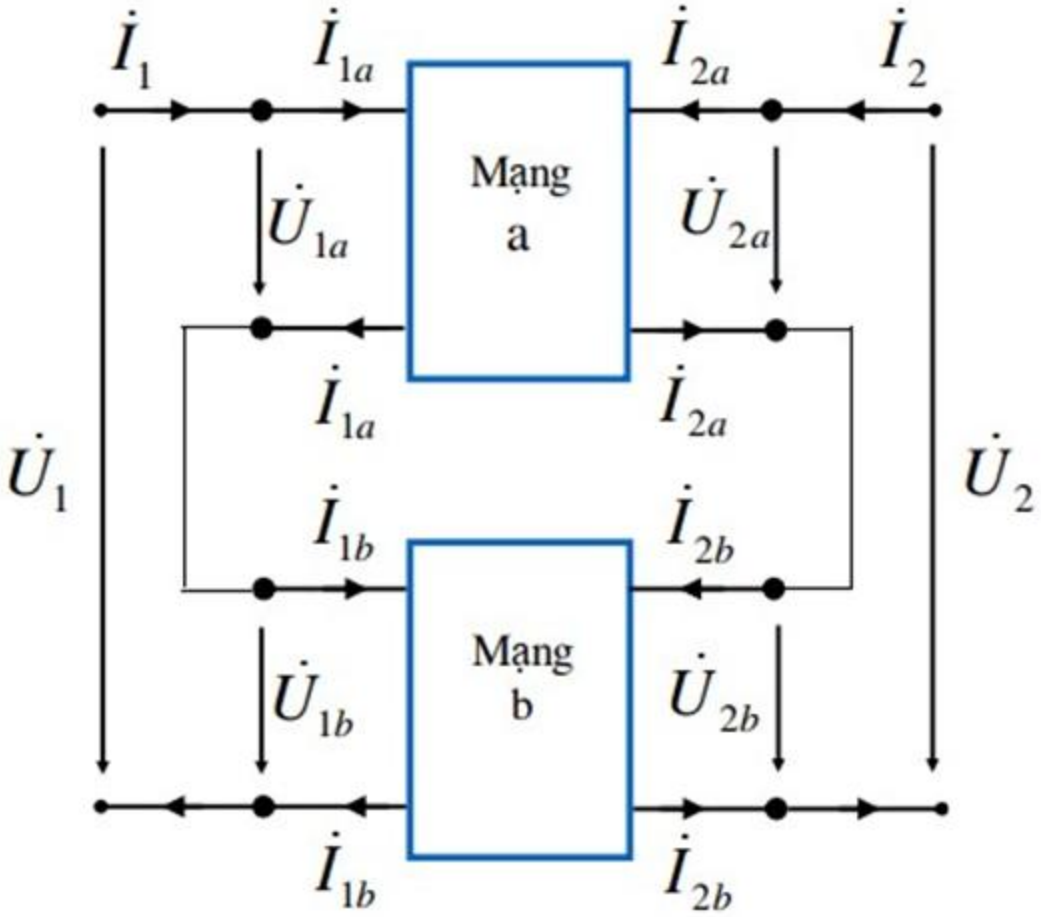


Nối tiếp



$$\begin{cases} i = i_1 = i_2 \\ u = u_1 + u_2 \end{cases}$$

$$\begin{cases} \dot{I}_1 = \dot{I}_{1a} = \dot{I}_{1b} \\ \dot{U}_1 = \dot{U}_{1a} + \dot{U}_{1b} \\ \dot{I}_2 = \dot{I}_{2a} = \dot{I}_{2b} \\ \dot{U}_2 = \dot{U}_{2a} + \dot{U}_{2b} \end{cases}$$



$$\begin{cases} \dot{I}_1 = \dot{I}_{1a} = \dot{I}_{1b} \\ \dot{U}_1 = \dot{U}_{1a} + \dot{U}_{1b} \\ \dot{I}_2 = \dot{I}_{2a} = \dot{I}_{2b} \\ \dot{U}_2 = \dot{U}_{2a} + \dot{U}_{2b} \end{cases}$$

Mạng a:

$$\begin{cases} \dot{U}_{1a} = Z_{11a}\dot{I}_{1a} + Z_{12a}\dot{I}_{2a} \\ \dot{U}_{2a} = Z_{21a}\dot{I}_{1a} + Z_{22a}\dot{I}_{2a} \end{cases}$$

Mạng b:

$$\begin{cases} \dot{U}_{1b} = Z_{11b}\dot{I}_{1b} + Z_{12b}\dot{I}_{2b} \\ \dot{U}_{2b} = Z_{21b}\dot{I}_{1b} + Z_{22b}\dot{I}_{2b} \end{cases}$$

$$\dot{I}_1 = \dot{I}_{1a} = \dot{I}_{1b}$$

$$\dot{I}_2 = \dot{I}_{2a} = \dot{I}_{2b}$$

$$\rightarrow \begin{cases} \begin{cases} \dot{U}_{1a} = Z_{11a}\dot{I}_1 + Z_{12a}\dot{I}_2 \\ \dot{U}_{2a} = Z_{21a}\dot{I}_1 + Z_{22a}\dot{I}_2 \end{cases} \\ \begin{cases} \dot{U}_{1b} = Z_{11b}\dot{I}_1 + Z_{12b}\dot{I}_2 \\ \dot{U}_{2b} = Z_{21b}\dot{I}_1 + Z_{22b}\dot{I}_2 \end{cases} \end{cases}$$

$$\begin{cases} \dot{I}_1 = \dot{I}_{1a} = \dot{I}_{1b} \\ \dot{U}_1 = \dot{U}_{1a} + \dot{U}_{1b} \\ \dot{I}_2 = \dot{I}_{2a} = \dot{I}_{2b} \\ \dot{U}_2 = \dot{U}_{2a} + \dot{U}_{2b} \end{cases}$$

Mạng a:

$$\begin{cases} \dot{U}_{1a} = Z_{11a}\dot{I}_1 + Z_{12a}\dot{I}_2 \\ \dot{U}_{2a} = Z_{21a}\dot{I}_1 + Z_{22a}\dot{I}_2 \end{cases}$$

Mạng b:

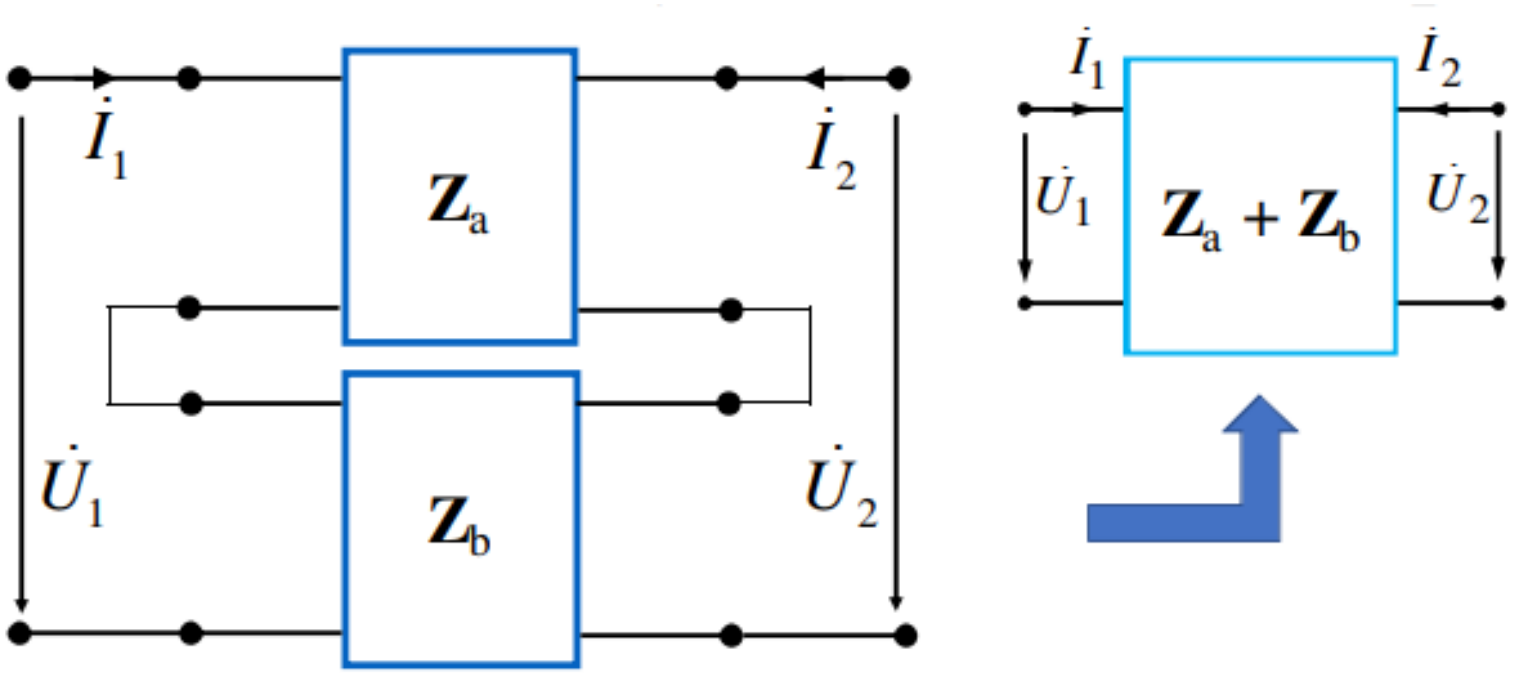
$$\begin{cases} \dot{U}_{1b} = Z_{11b}\dot{I}_1 + Z_{12b}\dot{I}_2 \\ \dot{U}_{2b} = Z_{21b}\dot{I}_1 + Z_{22b}\dot{I}_2 \end{cases}$$

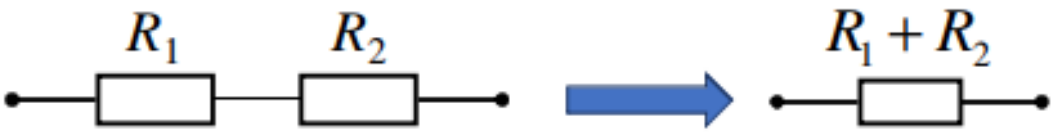
$$\begin{cases} \dot{U}_1 = \dot{U}_{1a} + \dot{U}_{1b} \\ \dot{U}_2 = \dot{U}_{2a} + \dot{U}_{2b} \end{cases} \rightarrow$$

$$\rightarrow \begin{cases} \dot{U}_1 = \dot{U}_{1a} + \dot{U}_{1b} = (Z_{11a}\dot{I}_1 + Z_{12a}\dot{I}_2) + (Z_{11b}\dot{I}_1 + Z_{12b}\dot{I}_2) \\ \dot{U}_2 = \dot{U}_{2b} + \dot{U}_{2b} = (Z_{21a}\dot{I}_1 + Z_{22a}\dot{I}_2) + (Z_{21b}\dot{I}_1 + Z_{22b}\dot{I}_2) \end{cases}$$

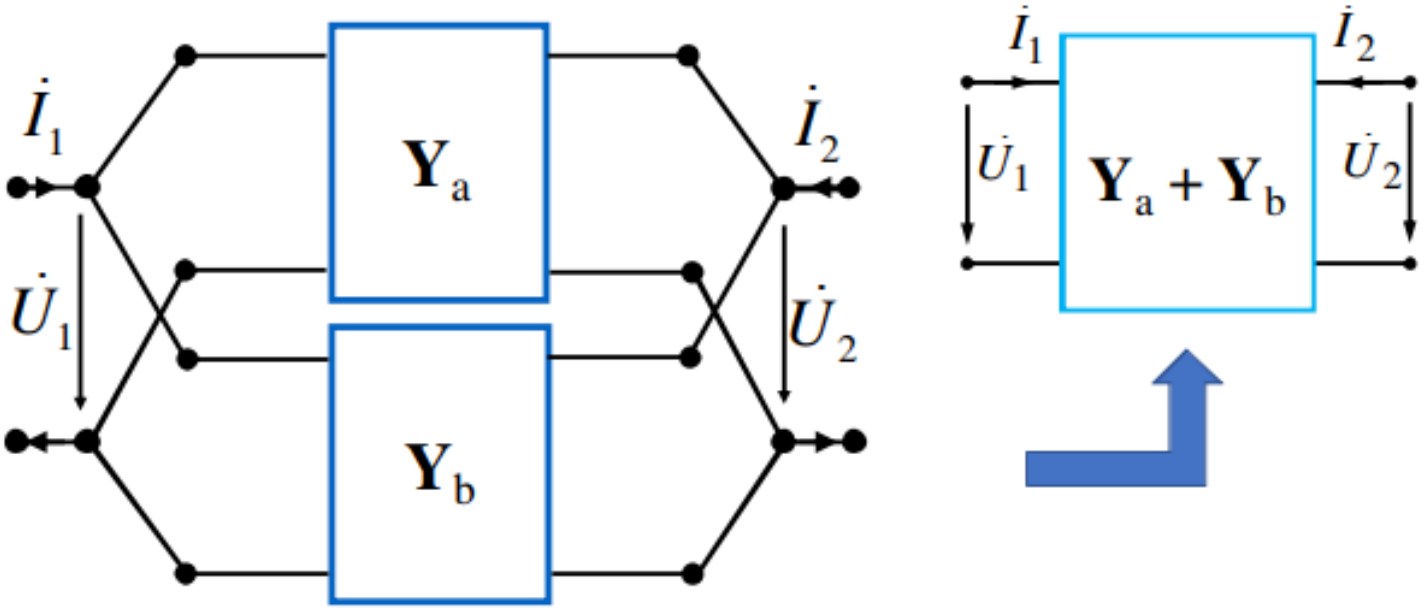
$$
\begin{cases}
\dot{I}_1 = \dot{I}_{1a} = \dot{I}_{1b} \\
\dot{U}_1 = \dot{U}_{1a} + \dot{U}_{1b} \\
\dot{I}_2 = \dot{I}_{2a} = \dot{I}_{2b} \\
\dot{U}_2 = \dot{U}_{2a} + \dot{U}_{2b}
\end{cases}
\left|
\begin{array}{l}
\begin{cases}
\dot{U}_1 = \dot{U}_{1a} + \dot{U}_{1b} = (Z_{11a}\dot{I}_1 + Z_{12a}\dot{I}_2) + (Z_{11b}\dot{I}_1 + Z_{12b}\dot{I}_2) \\
\dot{U}_2 = \dot{U}_{1b} + \dot{U}_{2b} = (Z_{21a}\dot{I}_1 + Z_{22a}\dot{I}_2) + (Z_{21b}\dot{I}_1 + Z_{22b}\dot{I}_2)
\end{cases} \\
\leftrightarrow \begin{cases}
\dot{U}_1 = (Z_{11a} + Z_{11b})\dot{I}_1 + (Z_{12a} + Z_{12b})\dot{I}_2 \\
\dot{U}_2 = (Z_{21a} + Z_{21b})\dot{I}_1 + (Z_{22a} + Z_{22b})\dot{I}_2
\end{cases} \\
\leftrightarrow \begin{bmatrix} \dot{U}_1 \\ \dot{U}_2 \end{bmatrix} = \begin{bmatrix} Z_{11a} + Z_{11b} & Z_{12a} + Z_{12b} \\ Z_{21a} + Z_{21b} & Z_{22a} + Z_{22b} \end{bmatrix} \begin{bmatrix} \dot{I}_1 \\ \dot{I}_2 \end{bmatrix} = [Z] \begin{bmatrix} \dot{I}_1 \\ \dot{I}_2 \end{bmatrix} \\
[Z_a] = \begin{bmatrix} Z_{11a} & Z_{12a} \\ Z_{21a} & Z_{22a} \end{bmatrix}; \quad [Z_b] = \begin{bmatrix} Z_{11b} & Z_{12b} \\ Z_{21b} & Z_{22b} \end{bmatrix}
\end{array}
\right\}
$$

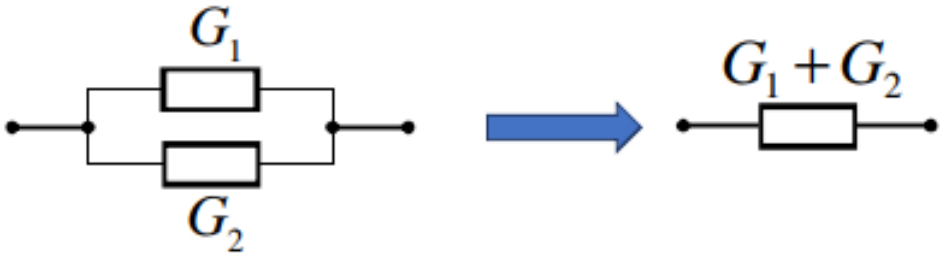
$$
\longrightarrow \boxed{[Z] = [Z_a] + [Z_b]}
$$


$\dot{I}_1$
$\dot{I}_2$
$\mathbf{Z}_a$
$\mathbf{Z}_b$
$\dot{U}_1$
$\dot{U}_2$
$\dot{I}_1$
$\dot{I}_2$
$\dot{U}_1$
$\mathbf{Z}_a + \mathbf{Z}_b$
$\dot{U}_2$

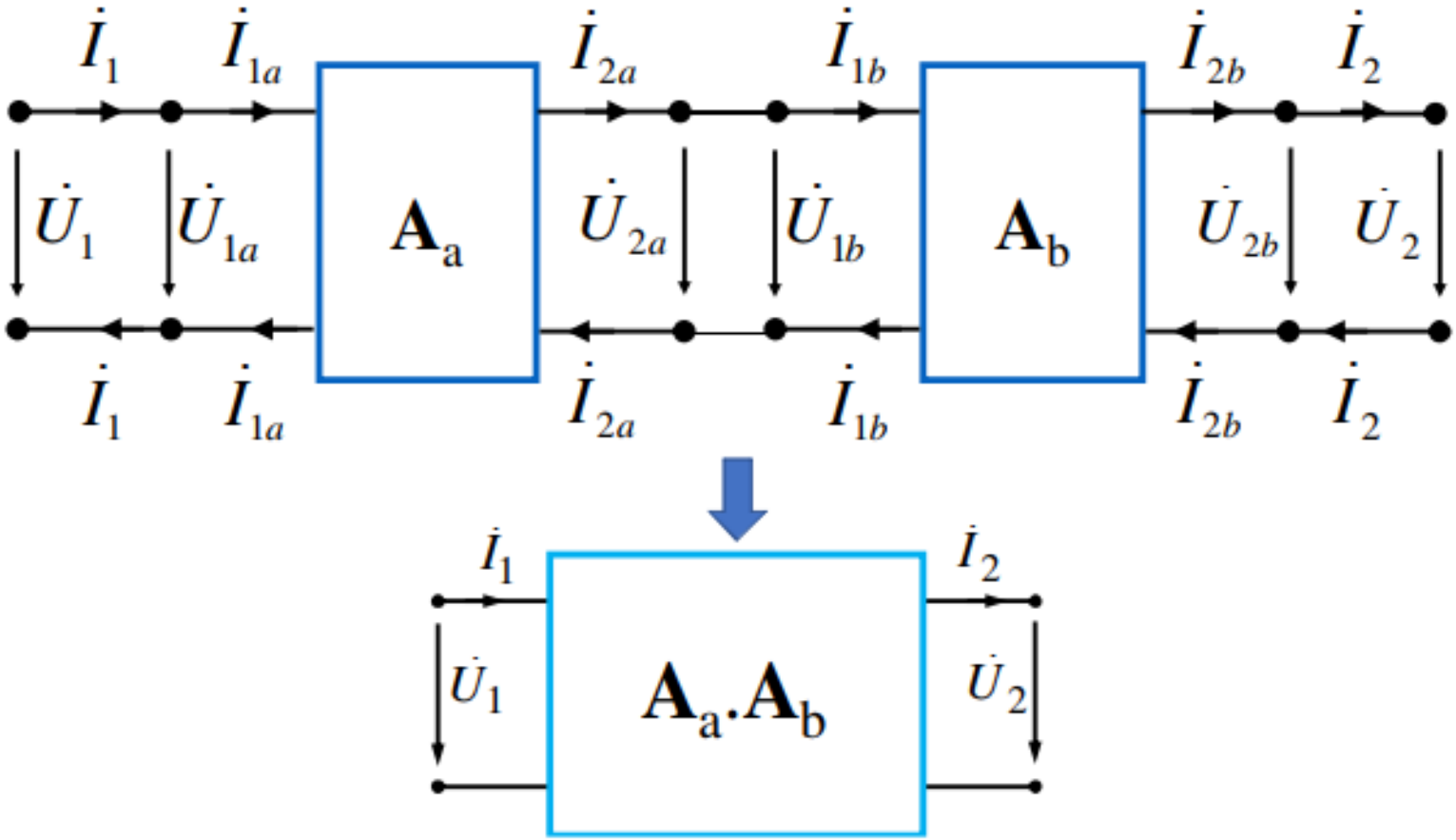

R_1
R_2
$R_1 + R_2$

2.4. Kết nối mạng 2 cửa: Song song

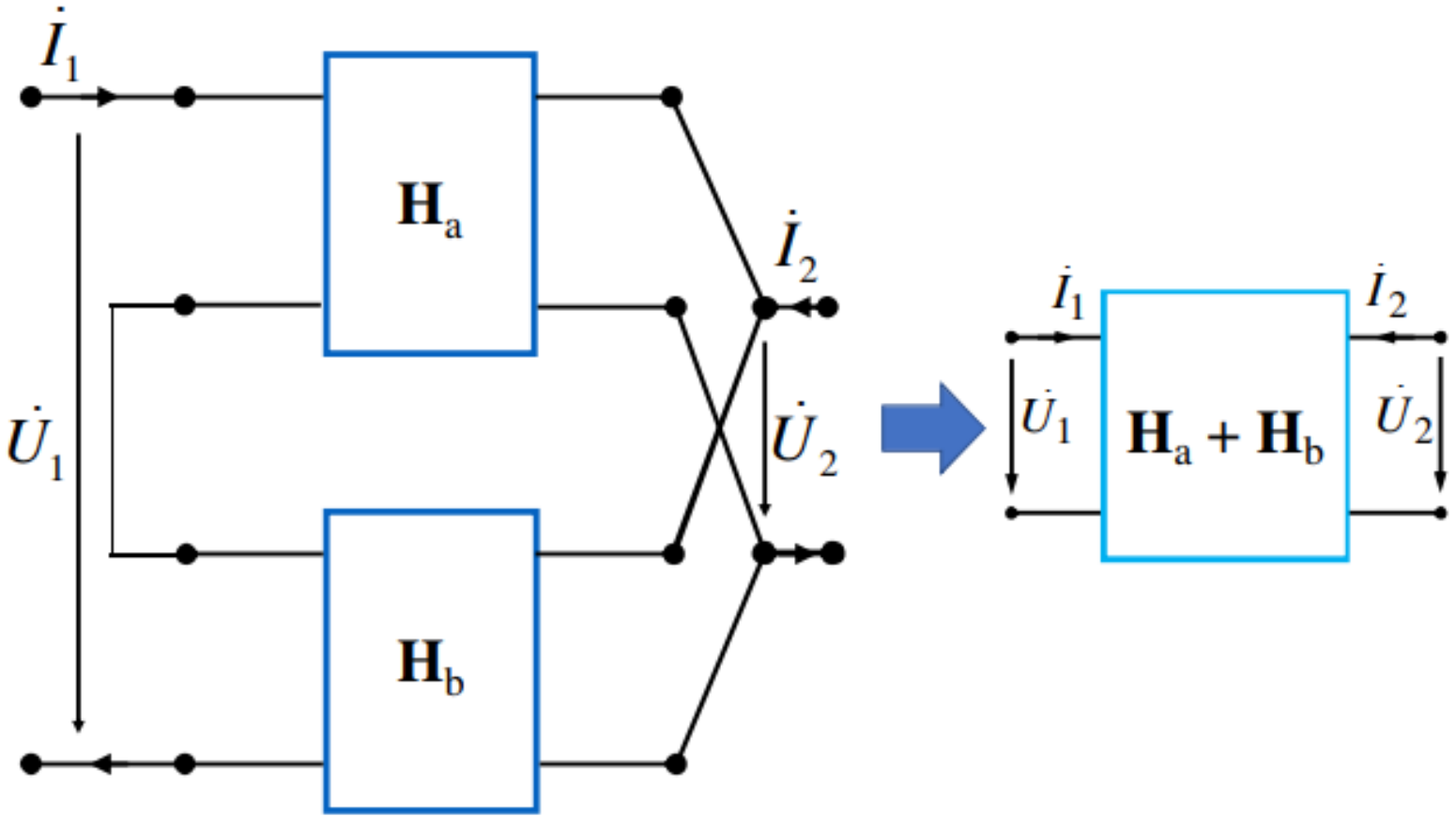


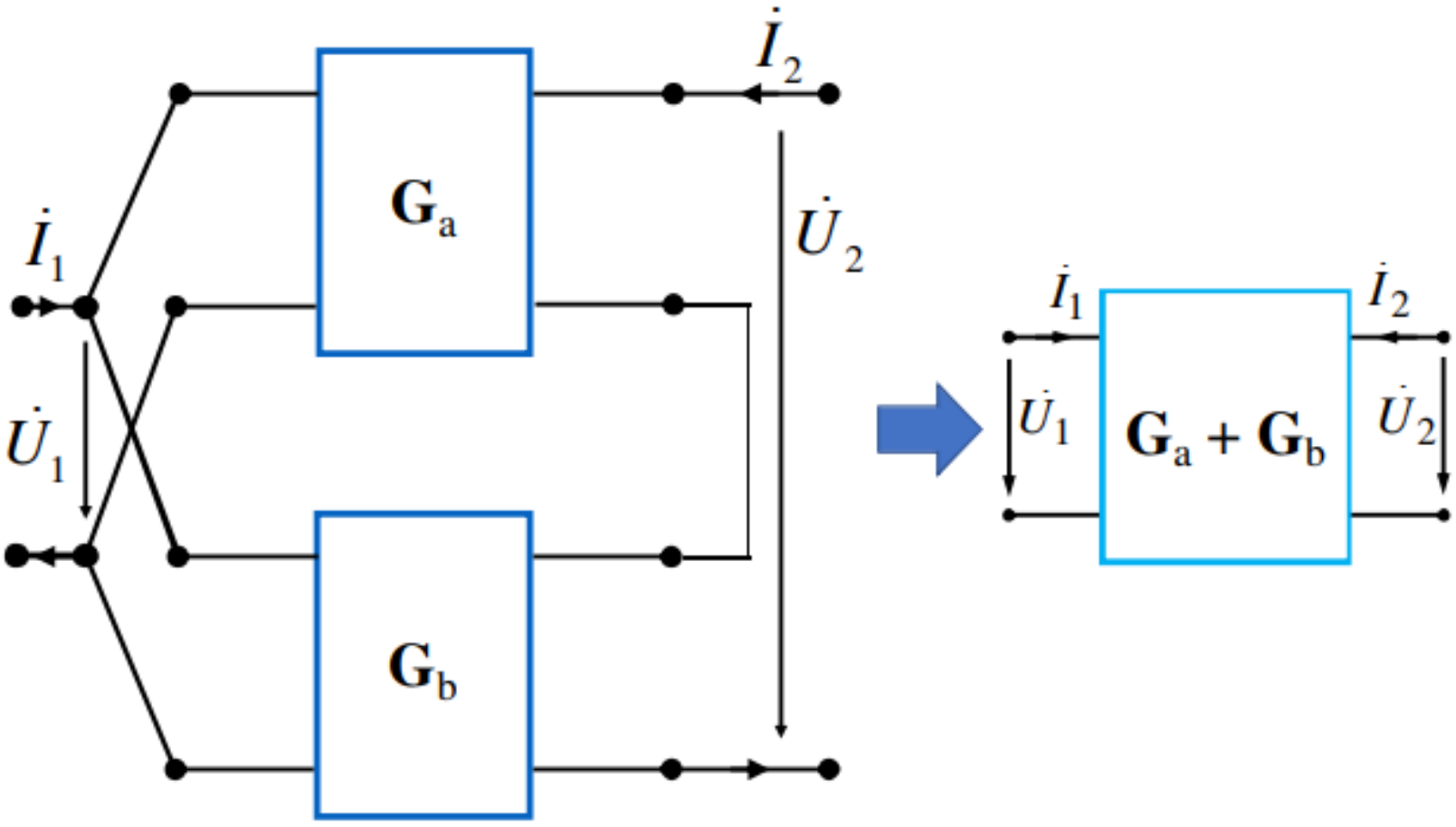


4.2. Kết nối mạng 2 cửa: Xâu chuỗi



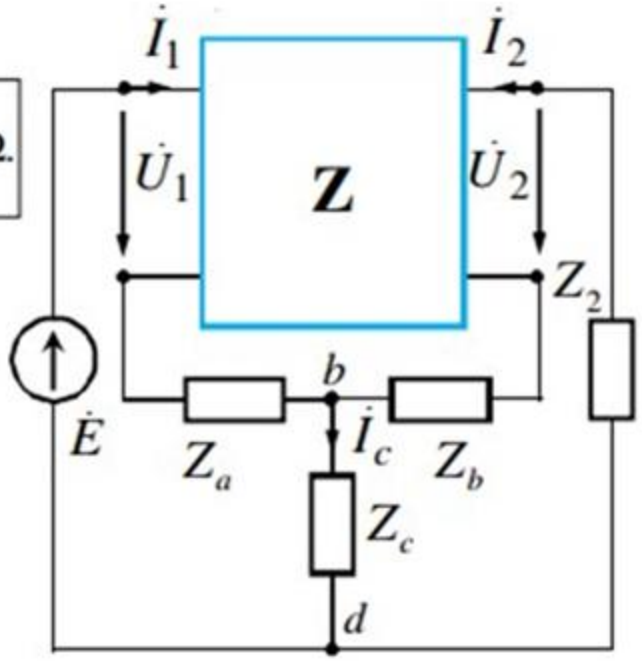
4.2. Kết nối mạng 2 cửa: lai




$\dot{I}_2$
$\mathbf{G}_a$
$\dot{I}_1$
$\dot{U}_2$
$\dot{U}_1$
$\mathbf{G}_b$
$\dot{I}_1$
$\dot{I}_2$
$\dot{U}_1$
$\mathbf{G}_a + \mathbf{G}_b$
$\dot{U}_2$

VD1

$$\dot{E} = 220\,\text{V};\ Z_2 = j10\ \Omega;\quad Z_a = j20\ \Omega;\ Z_b = -j40\ \Omega;\ Z_c = 5\ \Omega;\quad \mathbf{Z} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix}\ \Omega.$$



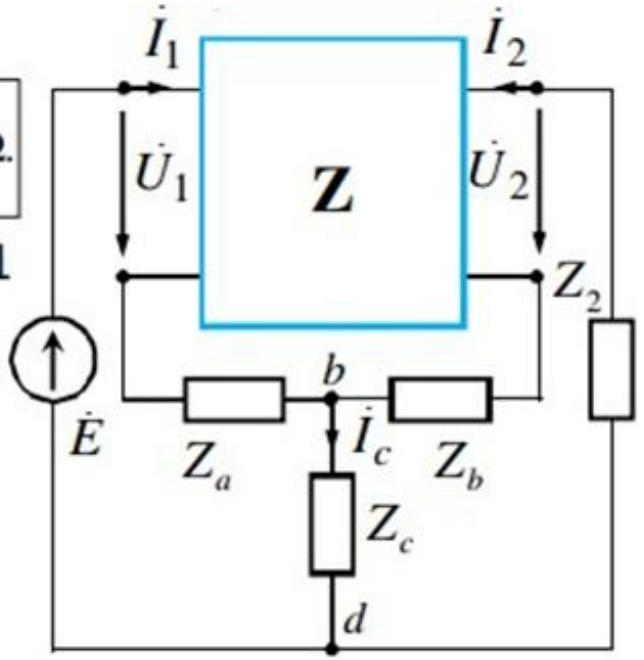
VD1

$$\dot{E} = 220\,\text{V};\ Z_2 = j10\ \Omega;\quad Z_a = j20\ \Omega;\ Z_b = -j40\ \Omega;\ Z_c = 5\ \Omega;\quad \mathbf{Z} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix}\ \Omega.$$

Cách 1

$$\begin{cases} \begin{cases} \dot{U}_1 = 30\dot{I}_1 + 20\dot{I}_2 \\ \dot{U}_2 = 20\dot{I}_1 + 50\dot{I}_2 \end{cases} \\ b:\ \dot{I}_1 + \dot{I}_2 - \dot{I}_c = 0 \\ A:\ \dot{U}_1 + Z_a\dot{I}_1 + Z_c\dot{I}_c = \dot{E} \\ B:\ Z_2\dot{I}_2 + \dot{U}_2 + Z_b\dot{I}_2 + Z_c\dot{I}_c = 0 \end{cases}$$

$$\rightarrow \begin{cases} \dot{I}_1 = 6,27 - j3,64\ \text{A} \\ \dot{I}_2 = -2,89 + j0,076\ \text{A} \\ \dot{I}_c = 3,38 - j3,56\ \text{A} \end{cases}$$



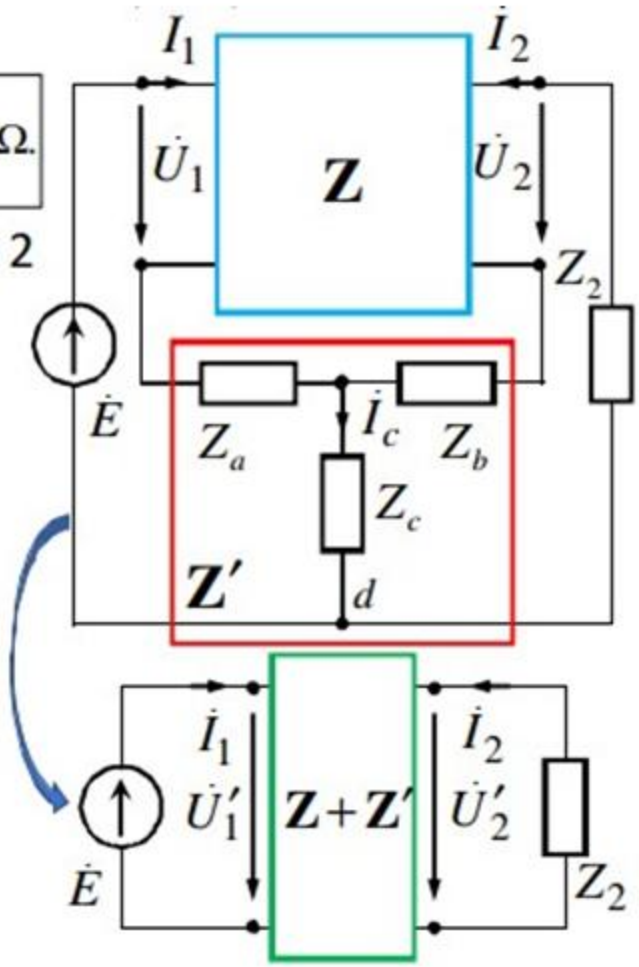
VD1

$$\dot{E} = 220\,\text{V};\ Z_2 = j10\ \Omega;\quad Z_a = j20\ \Omega;\ Z_b = -j40\ \Omega;\ Z_c = 5\ \Omega;\quad \mathbf{Z} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix}\Omega.$$

Cách 2

$$\mathbf{Z}' = \begin{bmatrix} Z_a + Z_c & Z_c \\ Z_c & Z_b + Z_c \end{bmatrix} = \begin{bmatrix} 5 + j20 & 5 \\ 5 & 5 - j40 \end{bmatrix}\Omega$$

$$\mathbf{Z} + \mathbf{Z}' = \begin{bmatrix} 35 + j20 & 25 \\ 25 & 55 - j40 \end{bmatrix}\Omega$$



VD1

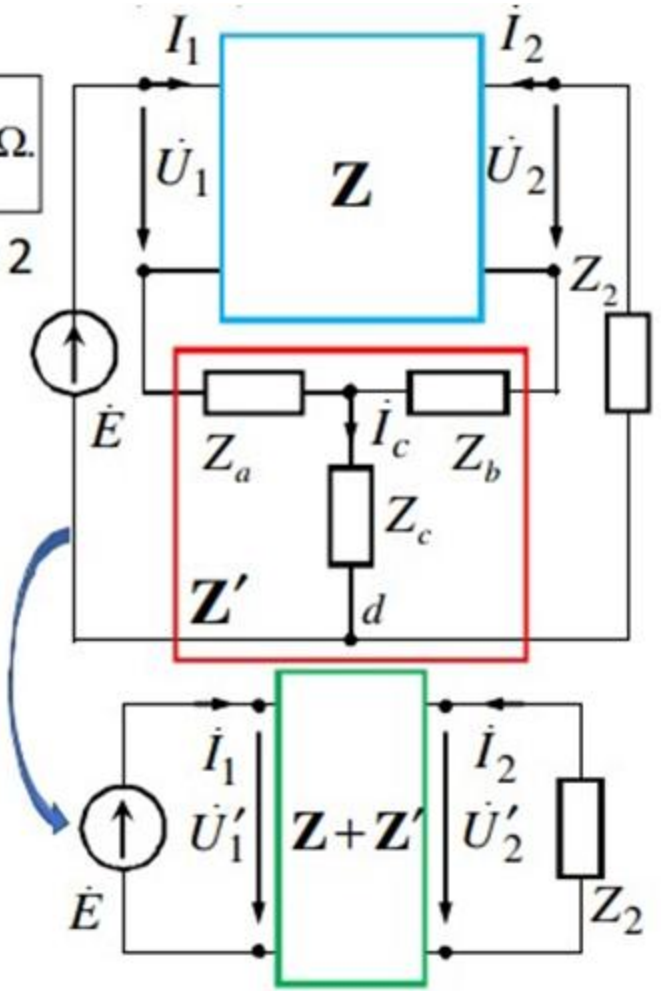
$$\dot{E} = 220\,\text{V};\ Z_2 = j10\ \Omega;\quad Z_a = j20\ \Omega;\ Z_b = -j40\ \Omega;\ Z_c = 5\ \Omega;\quad \mathbf{Z} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix}\Omega.$$

Cách 2

$$\mathbf{Z} + \mathbf{Z}' = \begin{bmatrix} 35 + j20 & 25 \\ 25 & 55 - j40 \end{bmatrix}\Omega$$

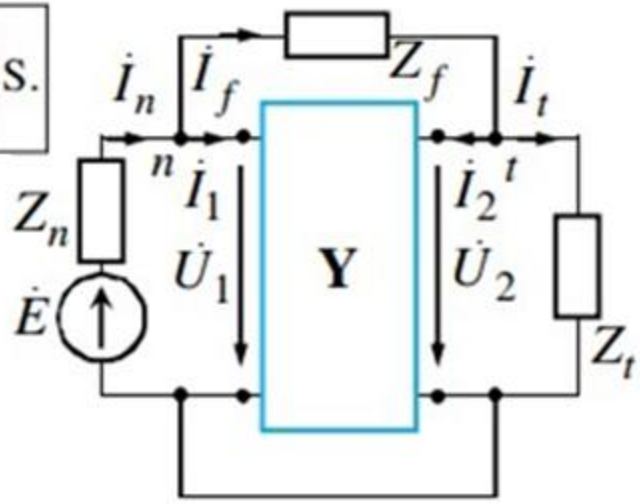
$$\begin{cases} \dot{U}_1' = (35 + j20)\dot{I}_1 + 25\dot{I}_2 = 220 \\ \dot{U}_2' = 25\dot{I}_1 + (55 - j40)\dot{I}_2 = -j10\dot{I}_2 \end{cases}$$

$$\rightarrow \begin{cases} \dot{I}_1 = 6,27 - j3,64\ \text{A} \\ \dot{I}_2 = -2,89 + j0,076\ \text{A} \end{cases}$$



VD3

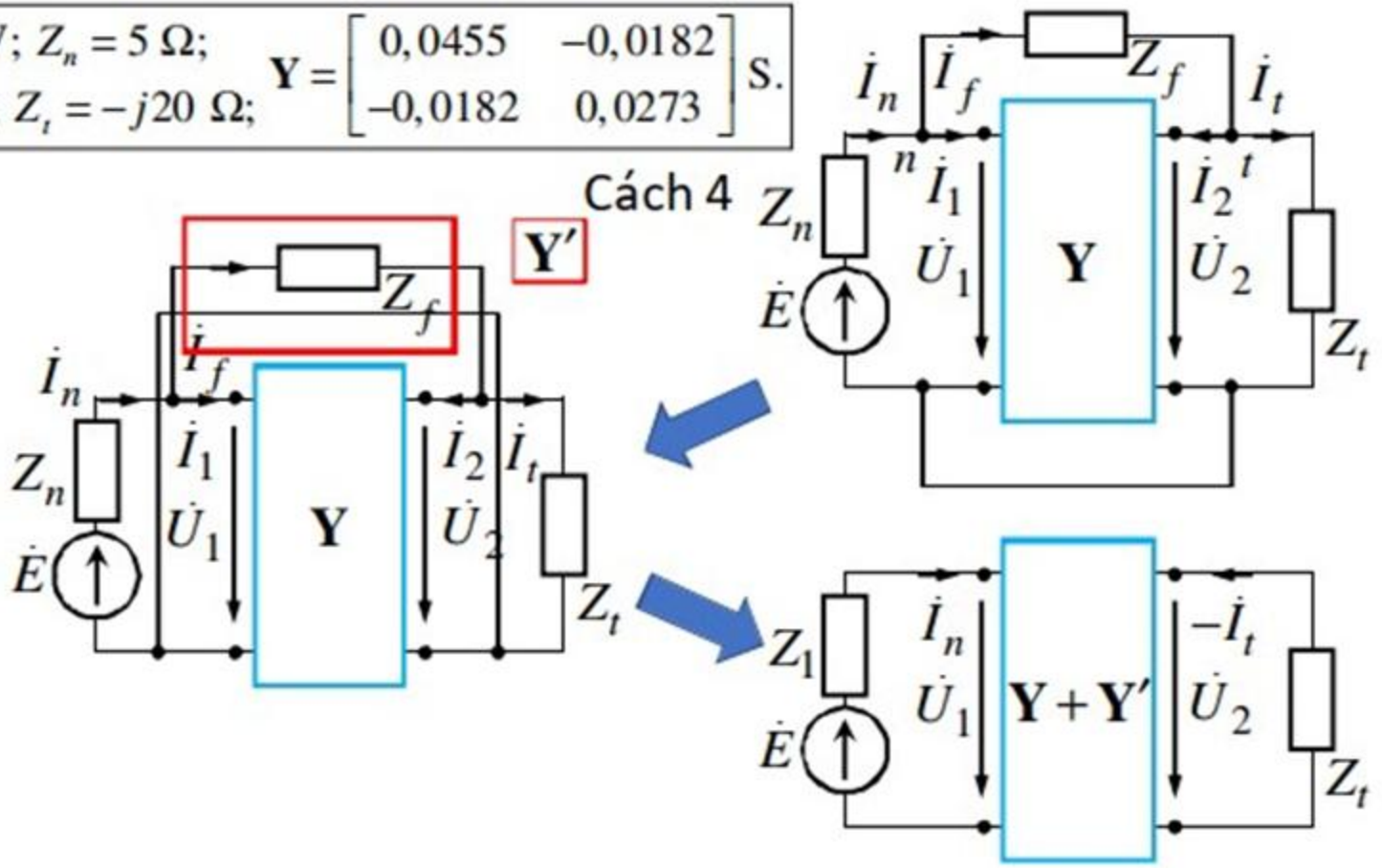
$$\dot{E} = 200\,\text{V};\ Z_n = 5\ \Omega;$$
$$Z_f = j10\ \Omega;\ Z_t = -j20\ \Omega;$$
$$\mathbf{Y} = \begin{bmatrix} 0,0455 & -0,0182 \\ -0,0182 & 0,0273 \end{bmatrix}\ \text{S}.$$



VD3

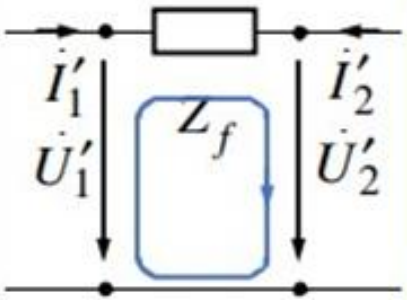
$\dot{E} = 200\,\text{V};\ Z_n = 5\ \Omega;$
$Z_f = j10\ \Omega;\ Z_t = -j20\ \Omega;$
$\mathbf{Y} = \begin{bmatrix} 0,0455 & -0,0182 \\ -0,0182 & 0,0273 \end{bmatrix}$ S.

Cách 4



VD3

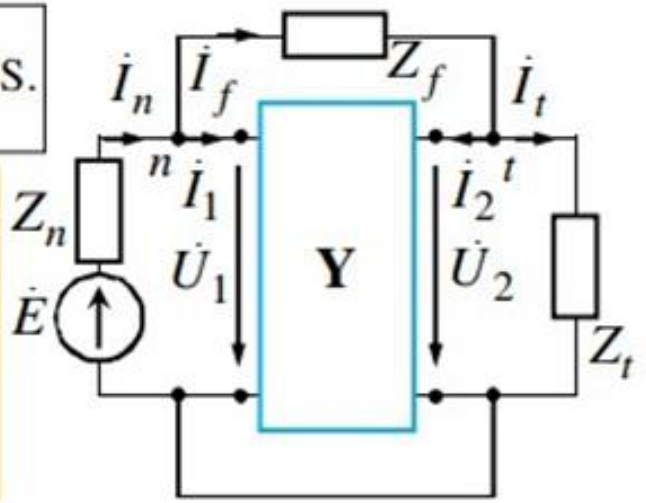
$\dot{E} = 200\,\text{V};\ Z_n = 5\,\Omega;$
$Z_f = j10\,\Omega;\ Z_t = -j20\,\Omega;$
$\mathbf{Y} = \begin{bmatrix} 0,0455 & -0,0182 \\ -0,0182 & 0,0273 \end{bmatrix}$ S.

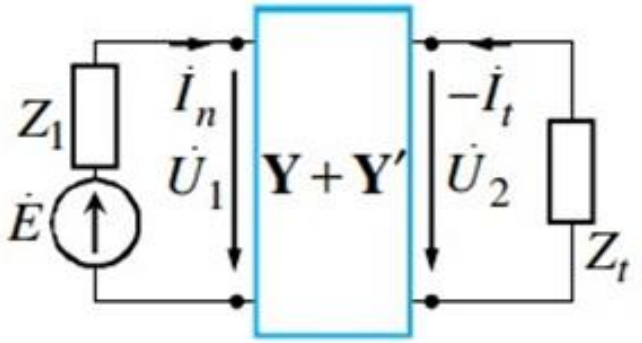


$$\begin{cases} -\dot{U}_1' + Z_f \dot{I}_1' + \dot{U}_2' = 0 \\ -\dot{U}_1' - Z_f \dot{I}_2' + \dot{U}_2' = 0 \end{cases}$$

$$\rightarrow \begin{cases} \dot{I}_1' = \dfrac{\dot{U}_1'}{Z_f} - \dfrac{\dot{U}_2'}{Z_f} \\ \dot{I}_2' = -\dfrac{\dot{U}_1'}{Z_f} + \dfrac{\dot{U}_2'}{Z_f} \end{cases}$$

$$\rightarrow \mathbf{Y}' = \begin{bmatrix} -j0,10 & j0,10 \\ j0,10 & -j0,10 \end{bmatrix} \text{S}$$





VD3

$$\dot{E} = 200\,\text{V};\ Z_n = 5\ \Omega;\quad Z_f = j10\ \Omega;\ Z_t = -j20\ \Omega;\quad \mathbf{Y} = \begin{bmatrix} 0,0455 & -0,0182 \\ -0,0182 & 0,0273 \end{bmatrix}\text{S}.$$

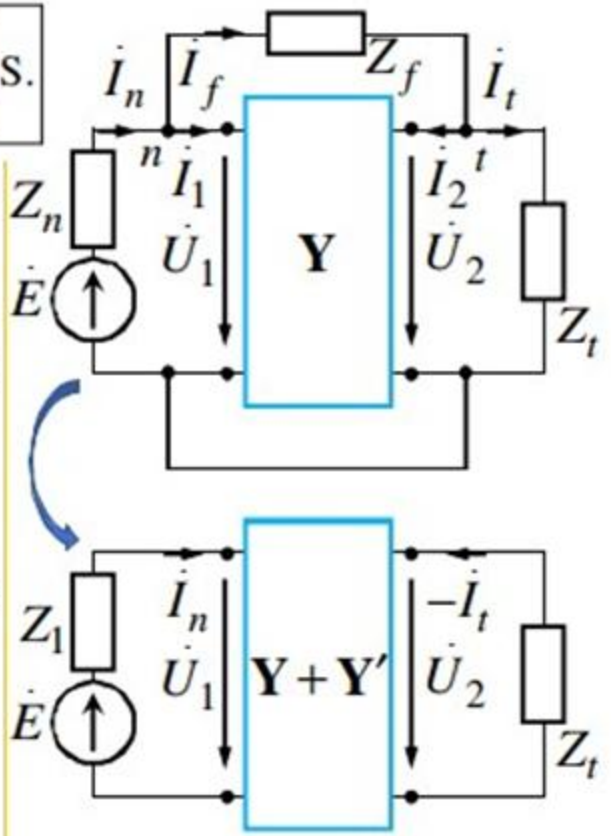
Cách 4

$$\mathbf{Y}' = \begin{bmatrix} -j0,10 & j0,10 \\ j0,10 & -j0,10 \end{bmatrix}\text{S}$$

$$\mathbf{Y}+\mathbf{Y}' = \begin{bmatrix} 0,0455-j0,10 & -0,0182+j0,10 \\ -0,0182+j0,10 & 0,0273-j0,10 \end{bmatrix}\text{S}$$

$$\begin{cases} \dot{I}_n = (0,0455-j0,10)\dot{U}_1 - (0,0182-j0,10)\dot{U}_2 \\ -\dot{I}_t = -(0,0182-j0,10)\dot{U}_1 + (0,0273-j0,10)\dot{U}_2 \\ 5\dot{I}_n + \dot{U}_1 = 200 \\ \dot{U}_2 + j20\dot{I}_t = 0 \end{cases}$$

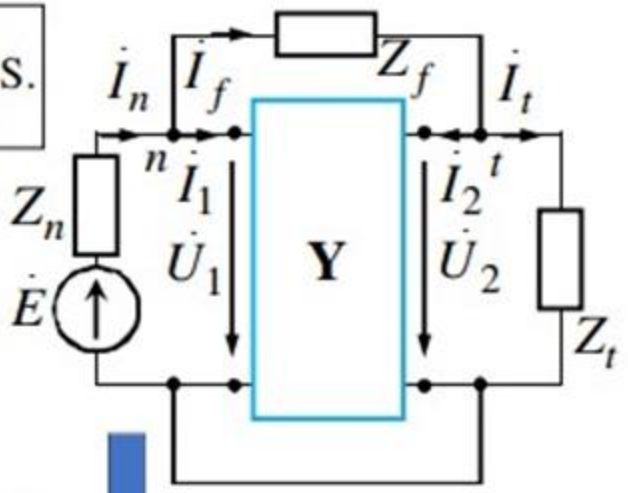
$$\rightarrow \begin{cases} \dot{I}_n = 12,76 + j8,02\ \text{A} \\ \dot{I}_t = 7,22 + j10,41\ \text{A} \end{cases}$$



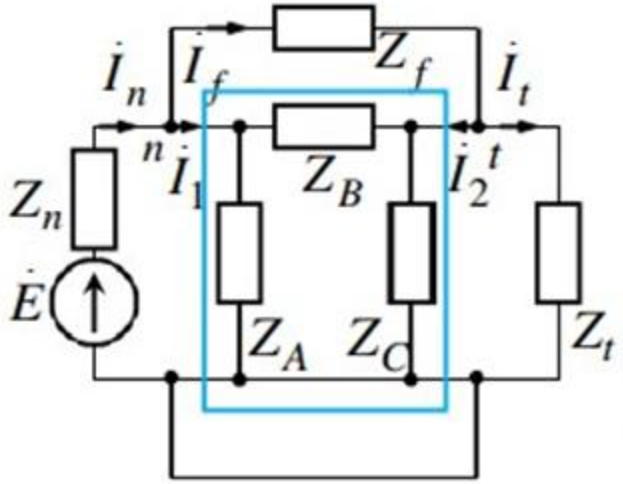
VD3

$\dot{E} = 200\,\text{V};\ Z_n = 5\ \Omega;$
$Z_f = j10\ \Omega;\ Z_t = -j20\ \Omega;$
$\mathbf{Y} = \begin{bmatrix} 0,0455 & -0,0182 \\ -0,0182 & 0,0273 \end{bmatrix}$ S.

Cách 5



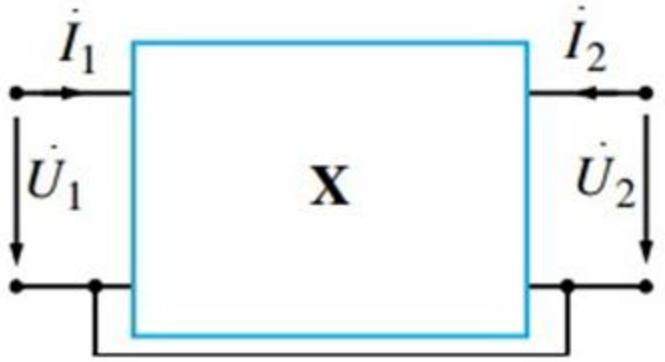
?

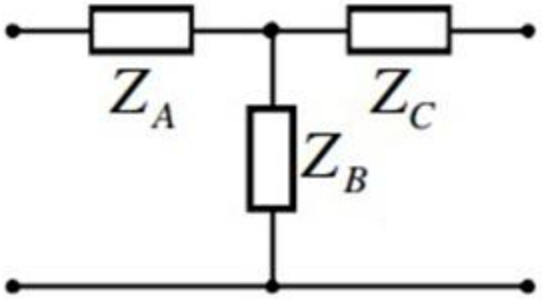


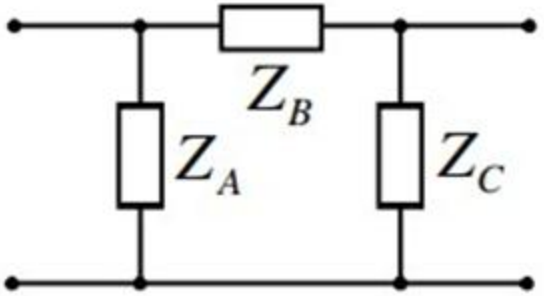
Mạng T & Π

2.5. Mạng T và Π

1. Tìm bộ số **X'** của mạng T hoặc Π,
2. **X** = **X'** (α),
3. Giải (α) để tìm các tổng trở của mạng T hoặc Π.





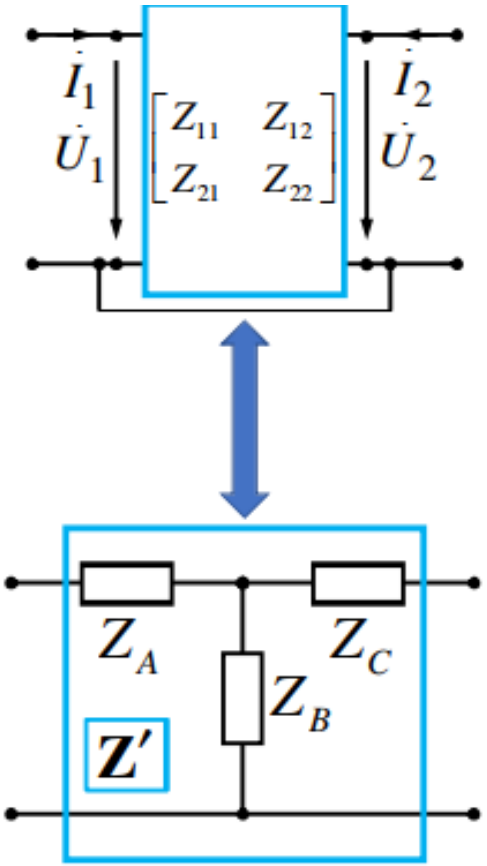


$$\mathbf{Z}' = \begin{bmatrix} Z_A + Z_B & Z_B \\ Z_B & Z_B + Z_C \end{bmatrix}$$

$$\mathbf{Z} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}$$

$$\mathbf{Z} = \mathbf{Z}'$$

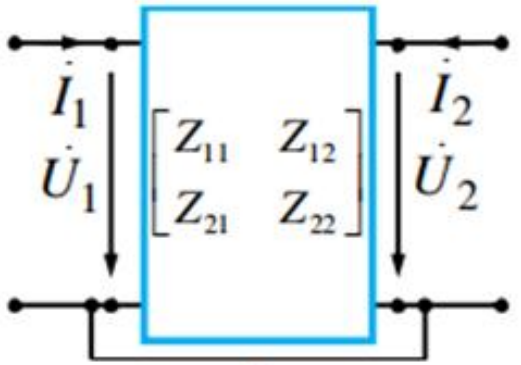
$$\rightarrow \begin{cases} Z_A + Z_B = Z_{11} \\ Z_B = Z_{12} \\ Z_B = Z_{21} \\ Z_B + Z_C = Z_{22} \end{cases} \rightarrow \begin{cases} Z_A = Z_{11} - Z_{12} \\ Z_B = Z_{12} \\ Z_C = Z_{22} - Z_{12} \end{cases}$$

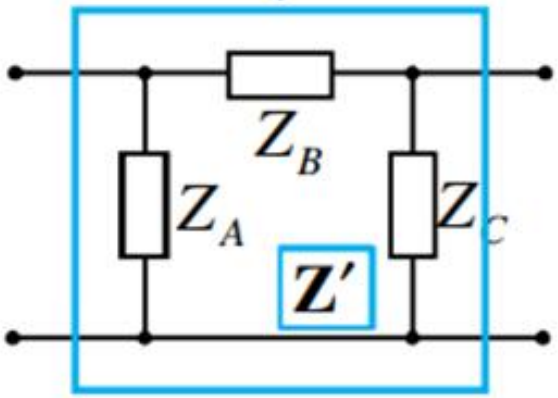


$$\mathbf{Z}' = \begin{bmatrix} \dfrac{Z_A(Z_B+Z_C)}{Z_A+Z_B+Z_C} & \dfrac{Z_A Z_C}{Z_A+Z_B+Z_C} \\ \dfrac{Z_A Z_C}{Z_A+Z_B+Z_C} & \dfrac{Z_C(Z_B+Z_A)}{Z_A+Z_B+Z_C} \end{bmatrix}$$

$$\mathbf{Z} = \mathbf{Z}'$$

$$\rightarrow \begin{cases} Z_A = \dfrac{Z_{11}Z_{22} - Z_{12}^2}{Z_{22} - Z_{12}} \\ Z_B = \dfrac{Z_{11}Z_{22} - Z_{12}^2}{Z_{12}} \\ Z_C = \dfrac{Z_{11}Z_{22} - Z_{12}^2}{Z_{11} - Z_{12}} \end{cases}$$



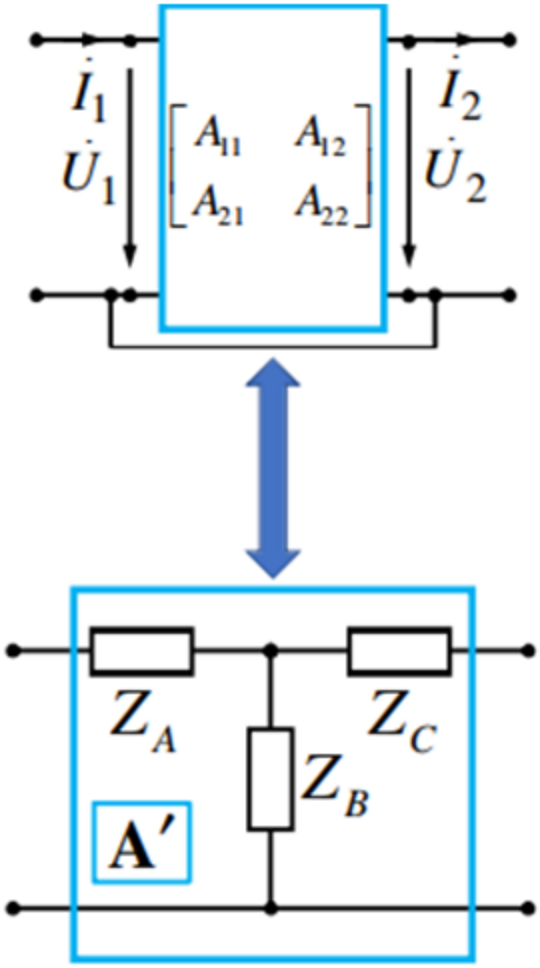


$$\mathbf{A}' = \begin{bmatrix} 1+\dfrac{Z_A}{Z_B} & Z_A + Z_C + \dfrac{Z_A Z_C}{Z_B} \\ \dfrac{1}{Z_B} & 1+\dfrac{Z_C}{Z_B} \end{bmatrix}$$

$$Z_A = \frac{A_{11}-1}{A_{21}}$$

$$Z_B = \frac{1}{A_{21}}$$

$$Z_C = \frac{A_{22}-1}{A_{21}}$$

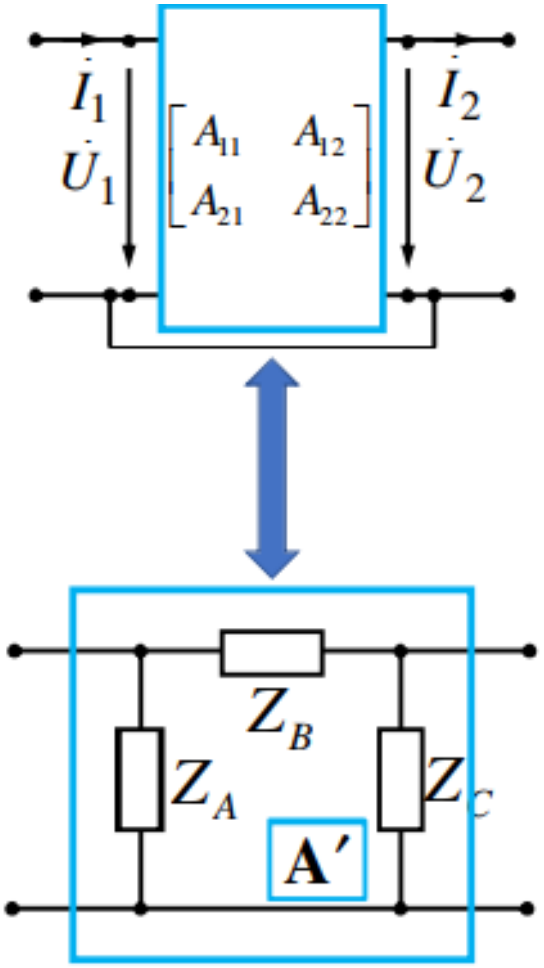


$$\mathbf{A}' = \begin{bmatrix} 1+\dfrac{Z_B}{Z_C} & Z_B \\ \dfrac{Z_A+Z_B+Z_C}{Z_A Z_C} & 1+\dfrac{Z_B}{Z_A} \end{bmatrix}$$

$$Z_A = \frac{A_{12}}{A_{22}-1}$$

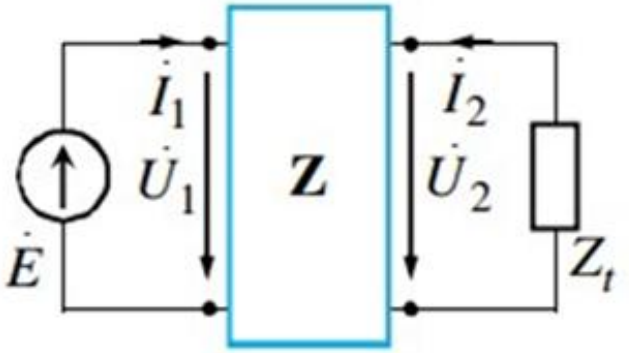
$$Z_B = A_{12}$$

$$Z_C = \frac{A_{12}}{A_{11}-1}$$



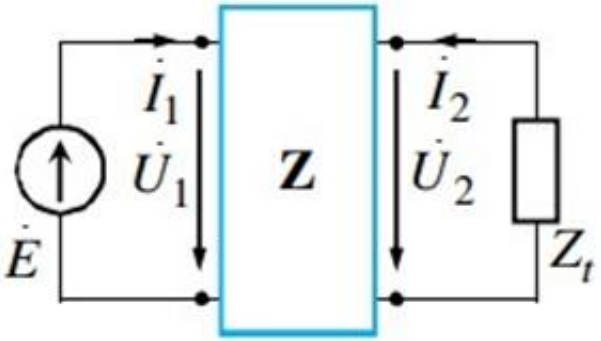
VD1

$$\dot{E} = 220\,\text{V};\ Z_t = j50\ \Omega;\ \mathbf{Z} = \begin{bmatrix} 10 & j20 \\ j20 & 40 \end{bmatrix}\ \Omega.$$



VD1

$$\dot{E} = 220\,\text{V};\ Z_t = j50\ \Omega;\ \mathbf{Z} = \begin{bmatrix} 10 & j20 \\ j20 & 40 \end{bmatrix}\ \Omega.$$

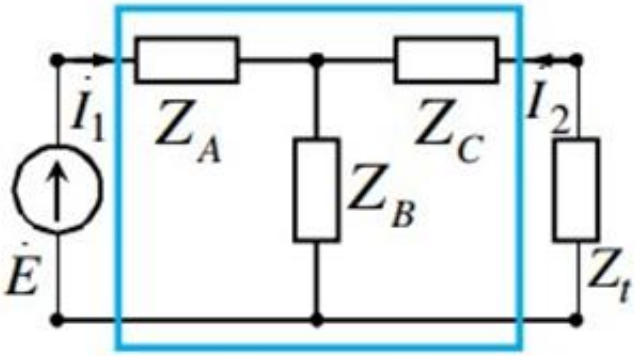


Cách 2

$$\begin{cases} Z_A = Z_{11} - Z_{12} = 10 - j20\ \Omega \\ Z_B = Z_{12} = j20\ \Omega \\ Z_C = Z_{22} - Z_{12} = 40 - j20\ \Omega \end{cases}$$

$$\dot{I}_1 = \frac{\dot{E}}{Z_A + Z_B\,//\,(Z_C + Z_t)} = \frac{220}{(10 - j20) + \dfrac{j20(40 - j20 + j50)}{j20 + 40 - j20 + j50}}$$

$$= \boxed{14,09 + j4,94\ \text{A}}$$



$$\dot{I}_2 = \frac{-\dot{I}_1 Z_B}{Z_B + Z_C + Z_t} = \frac{-(14,09 + j4,94)\,j20}{j20 + 40 - j20 + j50} =$$

$$= \boxed{-2,47 - j3,96\ \text{A}}$$

VD1

$$\dot{E} = 220\,\text{V};\ Z_t = j50\ \Omega;\ \mathbf{Z} = \begin{bmatrix} 10 & j20 \\ j20 & 40 \end{bmatrix}\Omega.$$

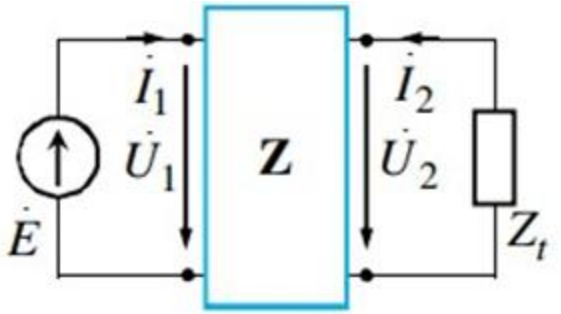
Cách 3

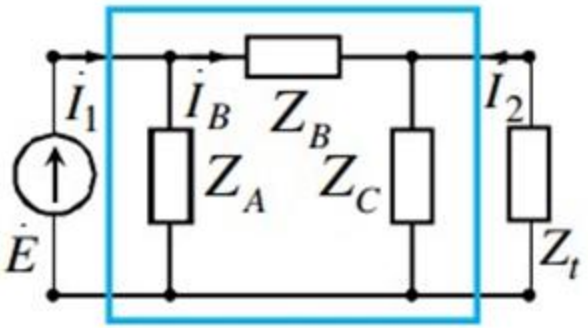
$$\begin{cases} Z_A = \dfrac{Z_{11}Z_{22} - Z_{12}^2}{Z_{22} - Z_{12}} = 16 + j8\ \Omega \\ Z_B = \dfrac{Z_{11}Z_{22} - Z_{12}^2}{Z_{12}} = -j40\ \Omega \\ Z_C = \dfrac{Z_{11}Z_{22} - Z_{12}^2}{Z_{11} - Z_{12}} = 16 + j32\ \Omega \end{cases}$$

$$\dot{I}_1 = \frac{\dot{E}}{Z_A // [Z_B + (Z_C // Z_t)]} = \boxed{14,09 + j4,94\ \text{A}}$$

$$\dot{I}_B = \frac{\dot{E}}{Z_B + (Z_C // Z_t)} = 3,09 + j10,44\ \text{A}$$

$$\dot{I}_2 = \frac{-\dot{I}_B Z_C}{Z_C + Z_t} = \boxed{-2,47 - j3,96\ \text{A}}$$

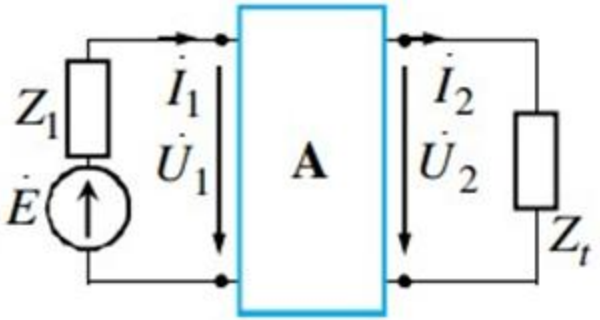




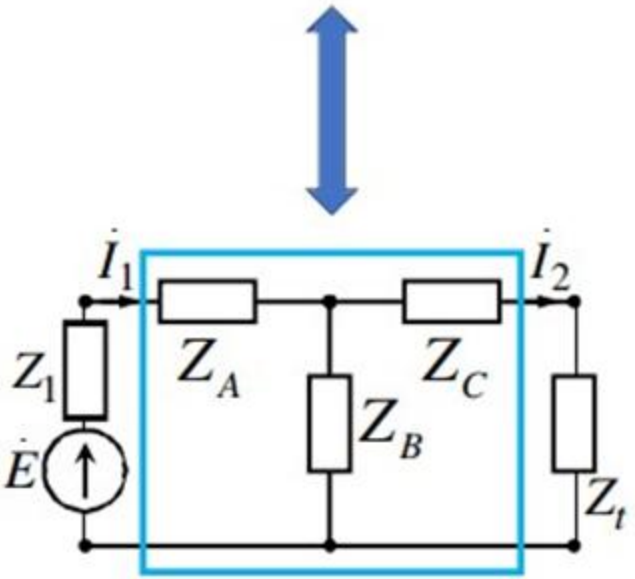
VD2

$$\dot{E} = 220\,\text{V}; \quad Z_1 = 20\,\Omega; \; Z_t = j50\;\Omega; \quad \mathbf{A} = \begin{bmatrix} 3 & 200 \\ 0,04 & 3 \end{bmatrix}.$$

Cách 2



$$\begin{cases} Z_A = \dfrac{A_{11}-1}{A_{21}} = \dfrac{3-1}{0,04} = 50\;\Omega \\ Z_B = \dfrac{1}{A_{21}} = 25\;\Omega \\ Z_C = \dfrac{A_{22}-1}{A_{21}} = 50\;\Omega \end{cases}$$



$$\dot{I}_1 = \frac{\dot{E}}{Z_1 + Z_A + Z_B // (Z_C + Z_t)} = \boxed{2,46 - j0,11\ \text{A}}$$

$$\dot{I}_2 = \frac{\dot{I}_1 Z_B}{Z_B + Z_C + Z_t} = \boxed{0,55 - j0,40\ \text{A}}$$

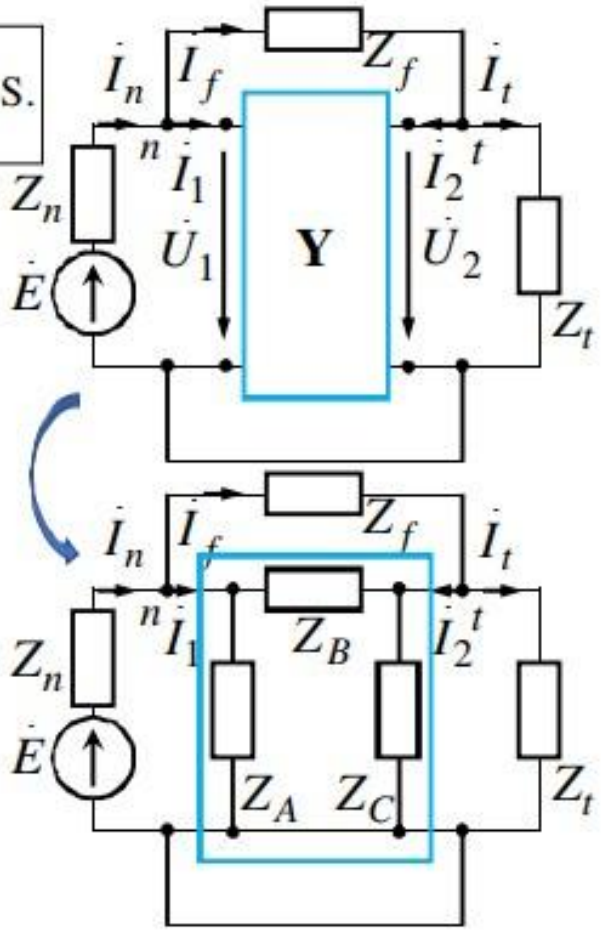
VD3

$$\dot{E} = 200\,\text{V};\ Z_n = 5\ \Omega;\quad Z_f = j10\ \Omega;\ Z_t = -j20\ \Omega;\quad \mathbf{Y} = \begin{bmatrix} 0,0455 & -0,0182 \\ -0,0182 & 0,0273 \end{bmatrix}\text{S}.$$

Cách 5

$$\mathbf{Z} = \mathbf{Y}^{-1} = \begin{bmatrix} 0,0455 & -0,0182 \\ -0,0182 & 0,0273 \end{bmatrix}^{-1} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix}\Omega$$

$$\begin{cases} Z_A = \dfrac{Z_{11}Z_{22} - Z_{12}^2}{Z_{22} - Z_{12}} = 36,67\ \Omega \\ Z_B = \dfrac{Z_{11}Z_{22} - Z_{12}^2}{Z_{12}} = 55,00\ \Omega \\ Z_C = \dfrac{Z_{11}Z_{22} - Z_{12}^2}{Z_{11} - Z_{12}} = 110,00\ \Omega \end{cases}$$



VD3

$\dot{E} = 200\,\text{V};\ Z_n = 5\ \Omega;$
$Z_f = j10\ \Omega;\ Z_t = -j20\ \Omega;$
$\mathbf{Y} = \begin{bmatrix} 0,0455 & -0,0182 \\ -0,0182 & 0,0273 \end{bmatrix}$ S.

Cách 5

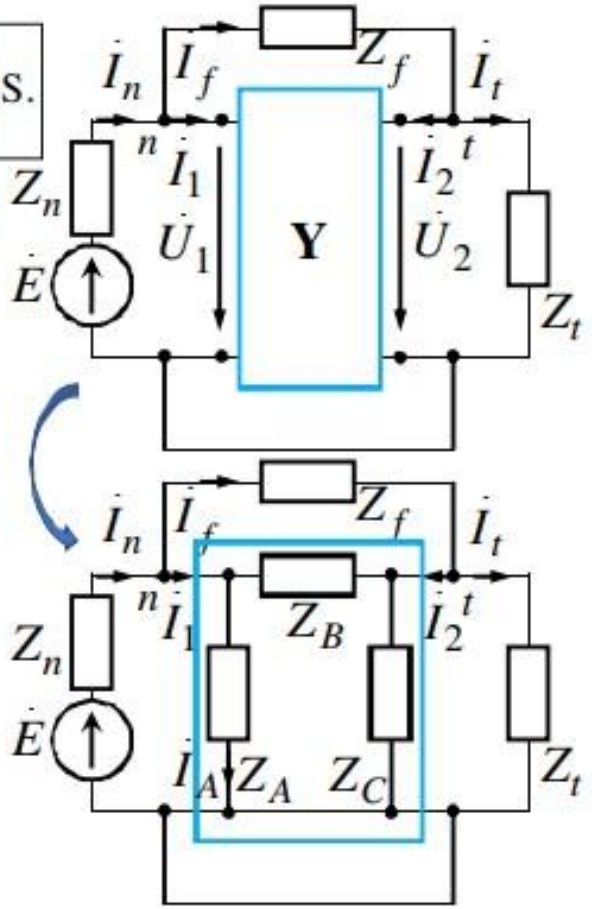
$Z_A = 36,67\ \Omega;\ Z_B = 55,00\ \Omega;\ Z_C = 110,00\ \Omega$

$$\dot{I}_n = \frac{\dot{E}}{Z_n + \{Z_A // [(Z_f // Z_B) + (Z_t // Z_C)]\}}$$

$$= \boxed{12,80 + j8,00\ \text{A}}$$

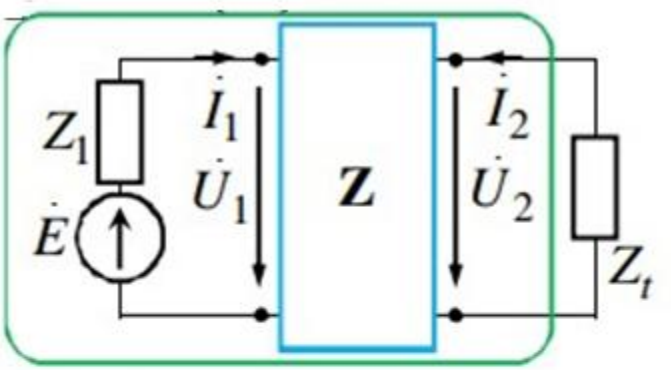
$$\dot{I}_A = \frac{\dot{E} - Z_n \dot{I}_n}{Z_A} = 3,71 - j1,09\ \text{A}$$

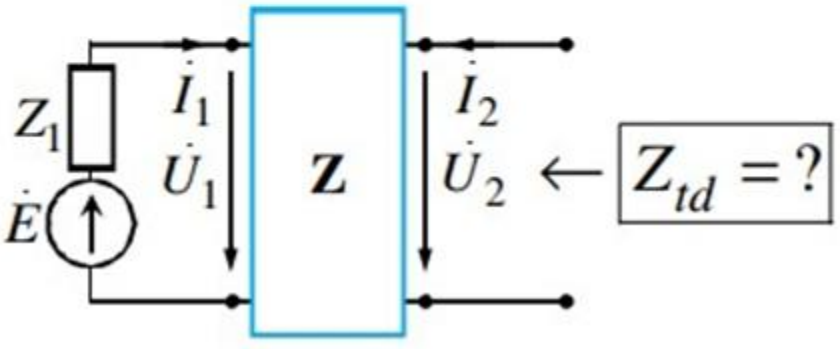
$$\dot{I}_t = \frac{(\dot{I}_n - \dot{I}_A) Z_C}{Z_C + Z_t} = \boxed{7,20 + j10,40\ \text{A}}$$

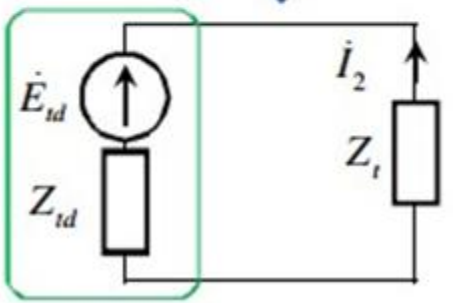


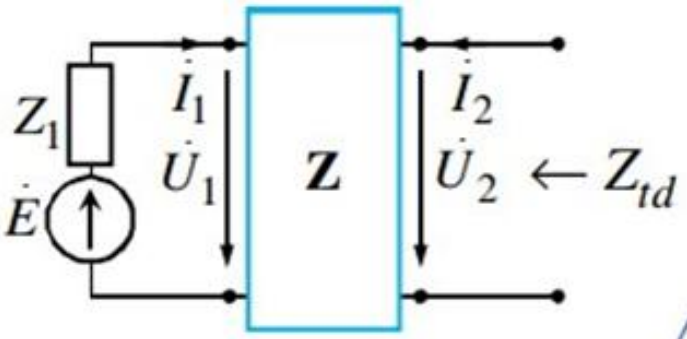
2.6. Tổng trở vào và hòa hợp tải

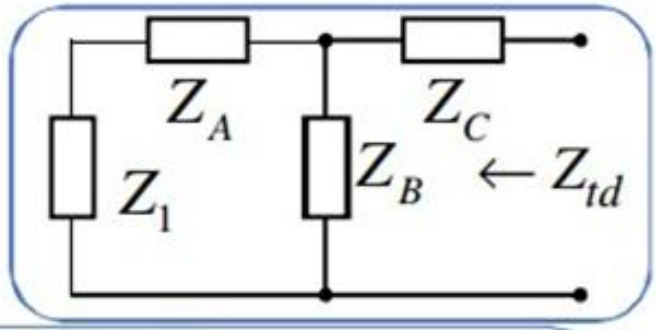
Để truyền công suất cực đại, tổng trở tải phải bằng liên hợp phức của tổng trở Thevenin

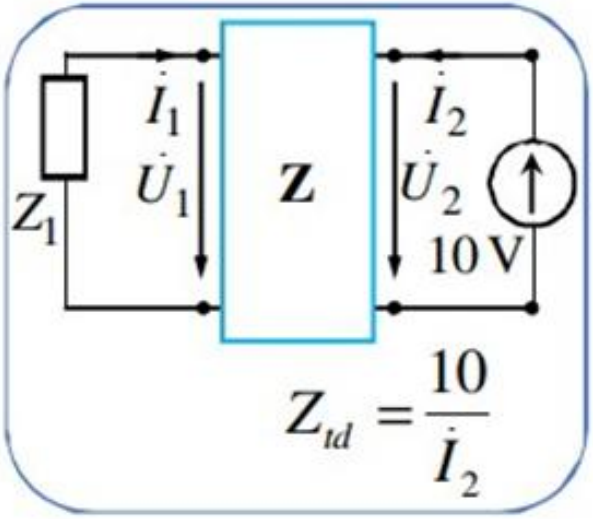


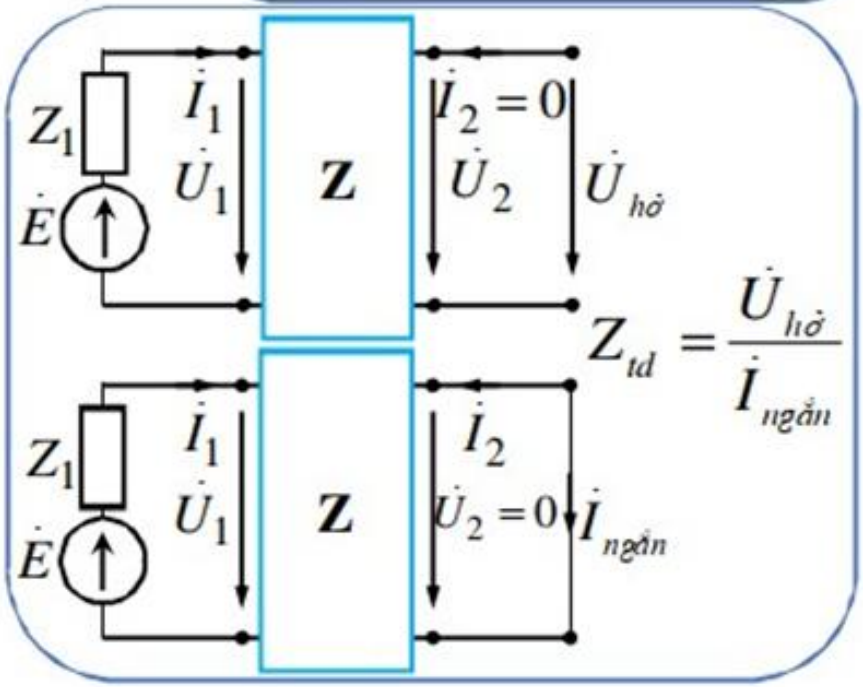


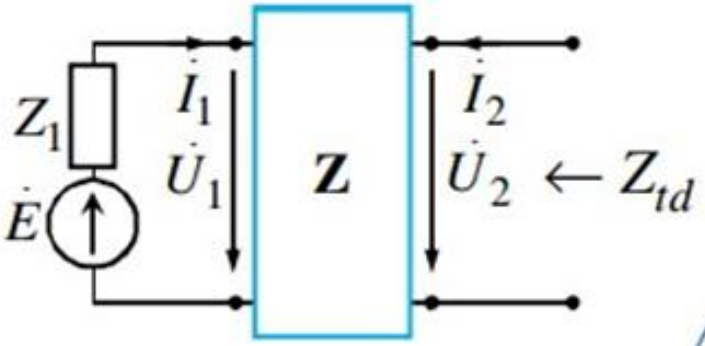


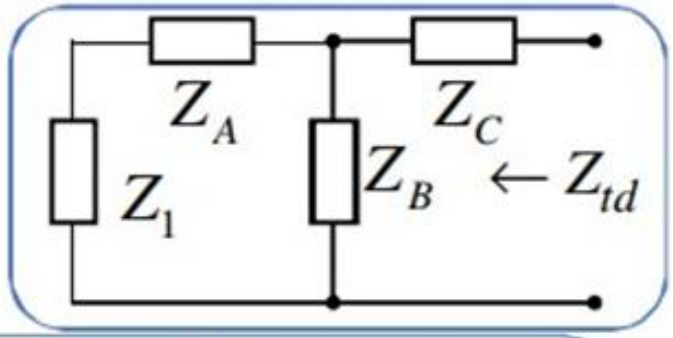

Z_1
$\dot{E}$
$\dot{I}_1$
$\dot{U}_1$
Z
$\dot{I}_2$
$\dot{U}_2$
$\leftarrow Z_{td}$

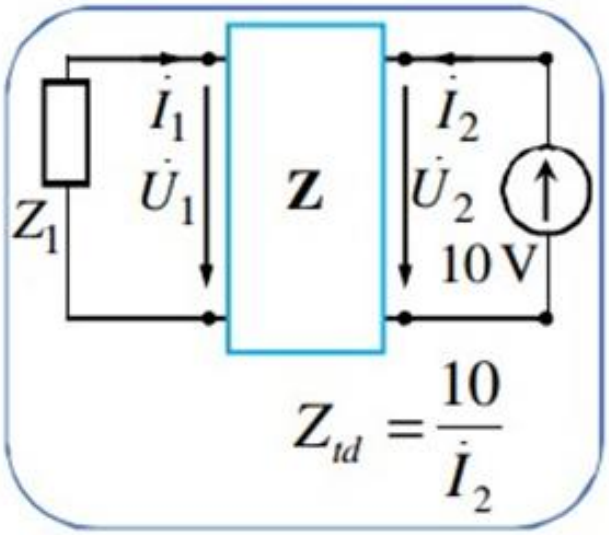

Z_A
Z_C
Z_1
Z_B
$\leftarrow Z_{td}$

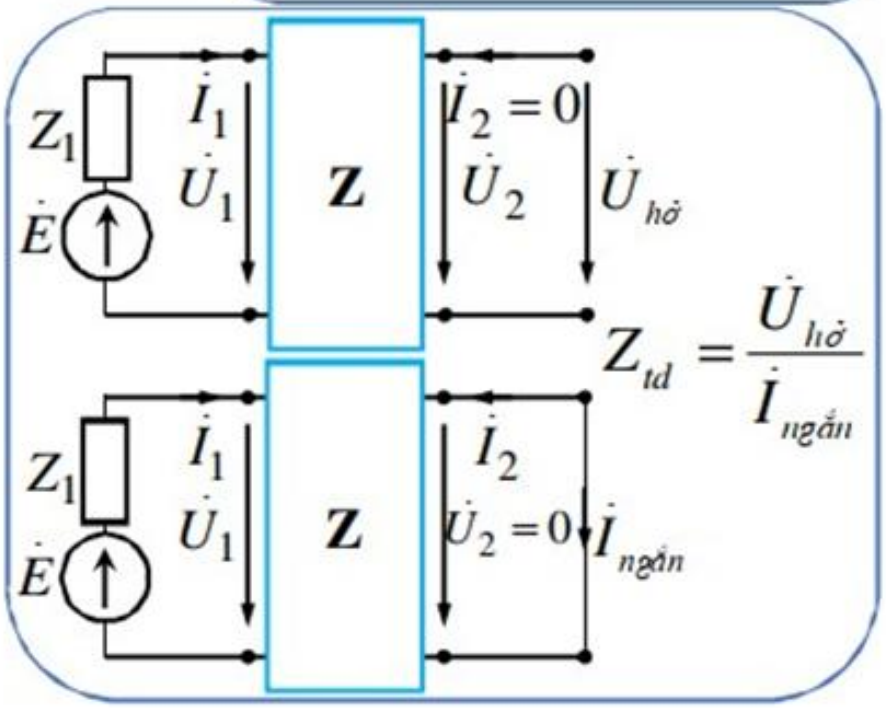

Z_1
$\dot{I}_1$
$\dot{U}_1$
Z
$\dot{I}_2$
$\dot{U}_2$
10 V
$Z_{td} = \frac{10}{\dot{I}_2}$


Z_1
$\dot{E}$
$\dot{I}_1$
$\dot{U}_1$
Z
$\dot{I}_2 = 0$
$\dot{U}_2$
$\dot{U}_{hở}$
$Z_{td} = \frac{\dot{U}_{hở}}{\dot{I}_{ngắn}}$
$\dot{I}_2$
$\dot{U}_2 = 0$
$\dot{I}_{ngắn}$


Z_1
$\dot{E}$
$\dot{I}_1$
$\dot{U}_1$
Z
$\dot{I}_2$
$\dot{U}_2$
$\leftarrow Z_{td}$


Z_A
Z_C
Z_1
Z_B
$\leftarrow Z_{td}$


Z_1
$\dot{I}_1$
$\dot{U}_1$
Z
$\dot{I}_2$
$\dot{U}_2$
10 V
$Z_{td} = \frac{10}{\dot{I}_2}$


Z_1
$\dot{E}$
$\dot{I}_1$
$\dot{U}_1$
Z
$\dot{I}_2 = 0$
$\dot{U}_2$
$\dot{U}_{hở}$
$Z_{td} = \frac{\dot{U}_{hở}}{\dot{I}_{ngắn}}$
$\dot{I}_2$
$\dot{U}_2 = 0$
$\dot{I}_{ngắn}$

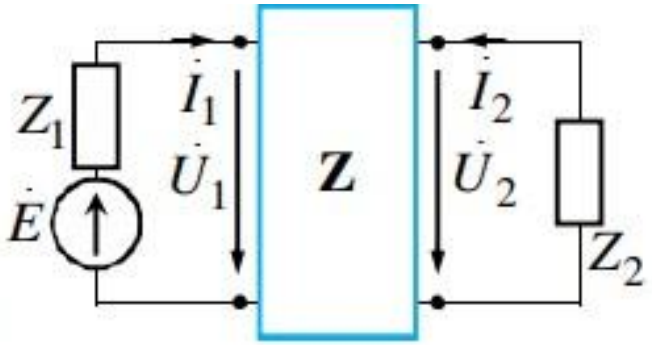
VD1

$$\mathbf{Z} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix}\Omega; \quad \dot{E} = 220\,\text{V}, \quad Z_1 = 15 + j25\,\Omega$$

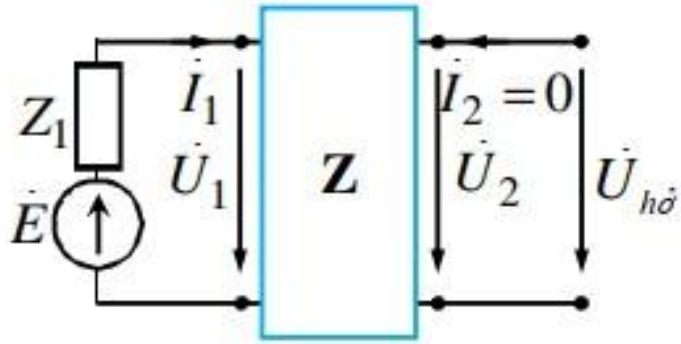
Tìm Z_2 để P_{Z2} cực đại?

Cách 2

$$Z_2 = \hat{Z}_{td}$$



$$\begin{cases} \begin{cases} \dot{U}_1 = 30\dot{I}_1 + 20\dot{I}_2 \\ \dot{U}_2 = 20\dot{I}_1 + 50\dot{I}_2 \end{cases} \\ (15 + j25)\dot{I}_1 + \dot{U}_1 = \dot{E} = 220 \\ \dot{I}_2 = 0 \end{cases}$$



$$\rightarrow \dot{U}_2 = 74,72 - j41,51\,\text{V} = \dot{U}_{hở}$$

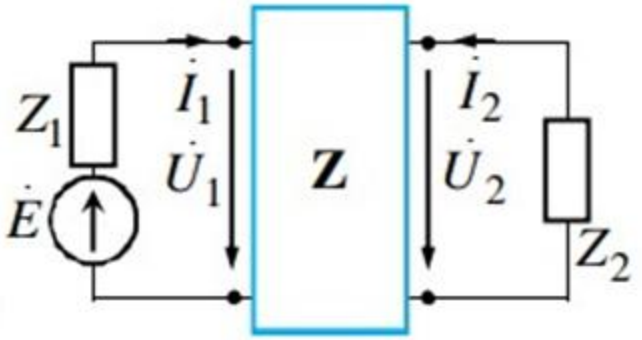
VD1

$$\mathbf{Z}=\begin{bmatrix}30 & 20\\ 20 & 50\end{bmatrix}\Omega;\quad \dot{E}=220\,\mathrm{V},\quad Z_1=15+j25\,\Omega$$

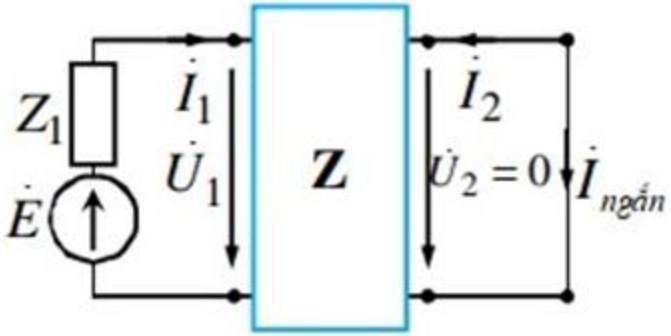
Tìm Z_2 để P_{Z2} cực đại?

Cách 2

$$Z_2=\hat{Z}_{td}$$



$$\begin{cases}\begin{cases}\dot{U}_1=30\dot{I}_1+20\dot{I}_2\\ \dot{U}_2=20\dot{I}_1+50\dot{I}_2\end{cases}\\ (15+j25)\dot{I}_1+\dot{U}_1=\dot{E}=220\\ \dot{U}_2=0\end{cases}$$



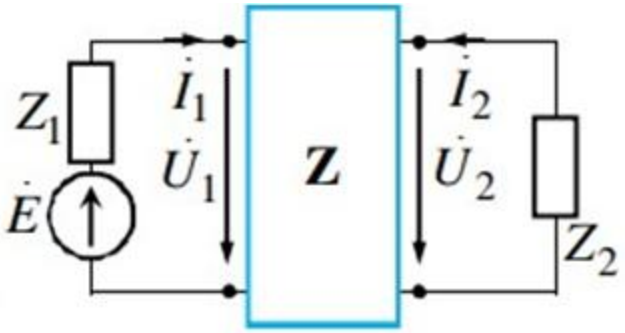
$$\rightarrow \dot{I}_2=-1,63+j1,10\,\mathrm{A}=-\dot{I}_{ngắn}$$

VD1

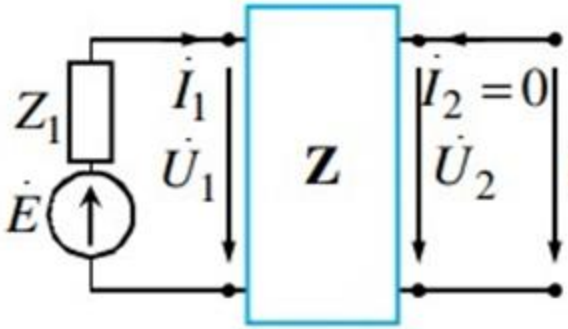
$$\mathbf{Z} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix} \Omega; \quad \dot{E} = 220\,\text{V}, \quad Z_1 = 15 + j25\,\Omega$$

Tìm Z_2 để P_{Z2} cực đại?

Cách 2

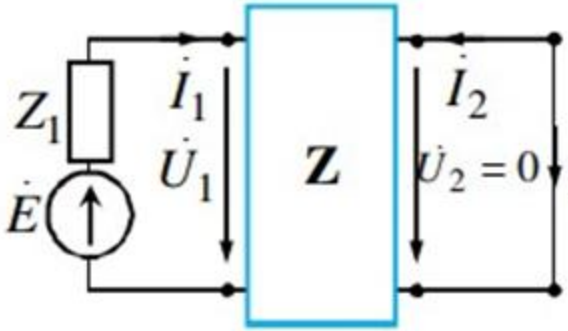


$$Z_2 = \hat{Z}_{td}$$



$$\dot{U}_{hở} = 74,72 - j41,51\,\text{V}$$

$$Z_{td} = \frac{\dot{U}_{hở}}{\dot{I}_{ngắn}}$$



$$\dot{I}_{ngắn} = 1,63 - j1,10\,\text{A}$$

$$\rightarrow Z_{td} = 43,31 + j3,77\,\Omega$$

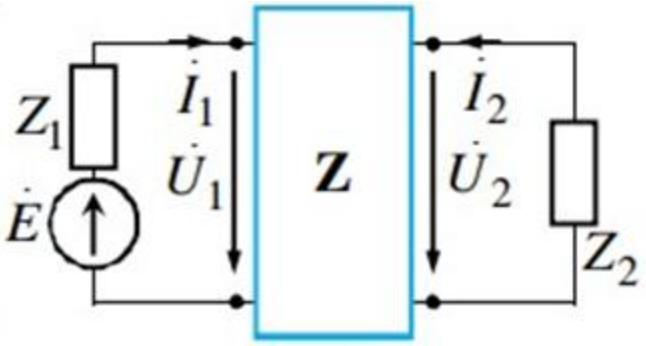
VD1

$$\mathbf{Z}=\begin{bmatrix}30 & 20\\ 20 & 50\end{bmatrix}\Omega;\quad \dot{E}=220\,\mathrm{V},\quad Z_1=15+j25\Omega$$

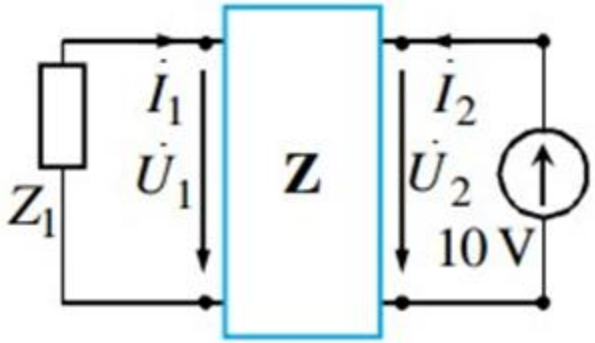
Tìm Z_2 để P_{Z2} cực đại?

Cách 3

$$Z_2=\hat{Z}_{td}$$



$$\begin{cases}\begin{cases}\dot{U}_1=30\dot{I}_1+20\dot{I}_2\\ \dot{U}_2=20\dot{I}_1+50\dot{I}_2\end{cases}\\ (15+j25)\dot{I}_1+\dot{U}_1=\dot{E}=220\\ \dot{U}_2=10\end{cases}$$



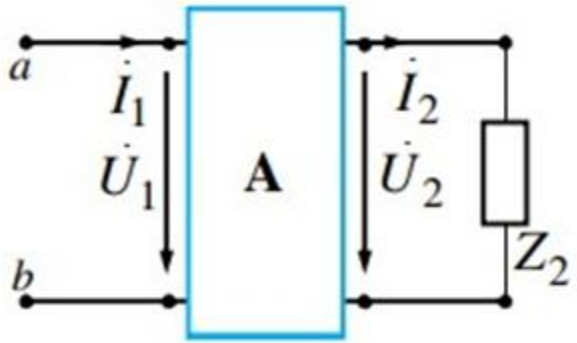
$$\rightarrow \dot{I}_2=0,023-j0,002\,\mathrm{A}\quad \rightarrow Z_{td}=\frac{10}{\dot{I}_2}=43,15+j3,75\Omega$$

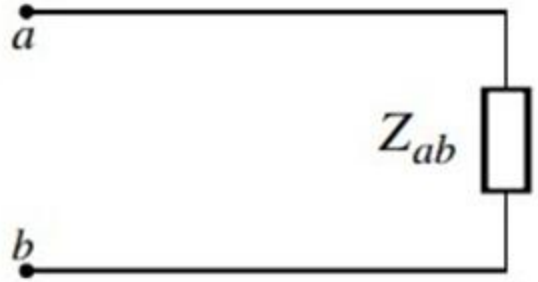
$$\begin{cases} \dot{U}_1 = A_{11}\dot{U}_2 + A_{12}\dot{I}_2 \\ \dot{I}_1 = A_{21}\dot{U}_2 + A_{22}\dot{I}_2 \end{cases}$$

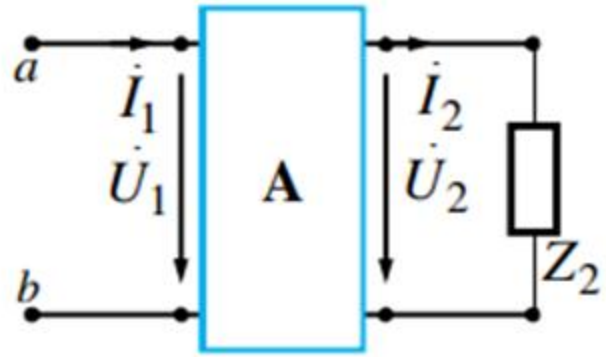
$$Z_{ab} = \frac{\dot{U}_1}{\dot{I}_1}$$

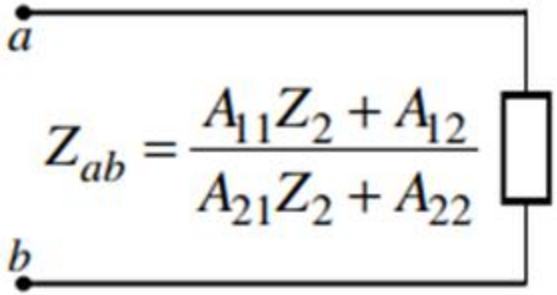
$$\dot{U}_2 = Z_2\dot{I}_2$$

$$\rightarrow \boxed{Z_{ab} = \frac{A_{11}Z_2 + A_{12}}{A_{21}Z_2 + A_{22}}}$$

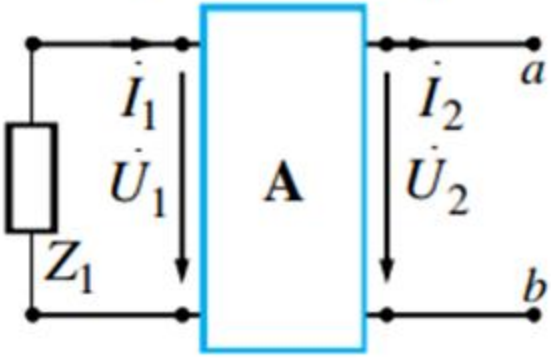


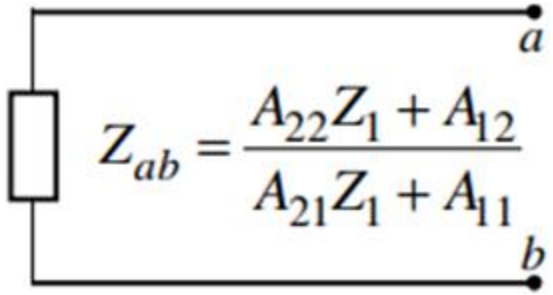


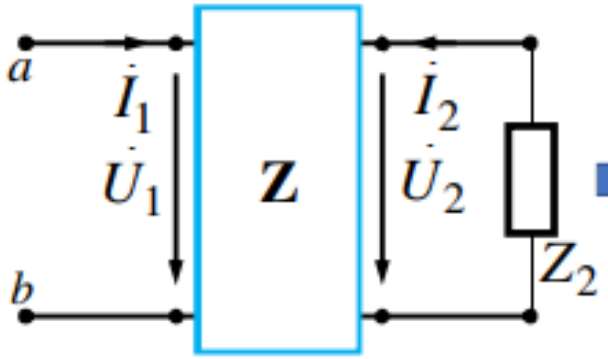


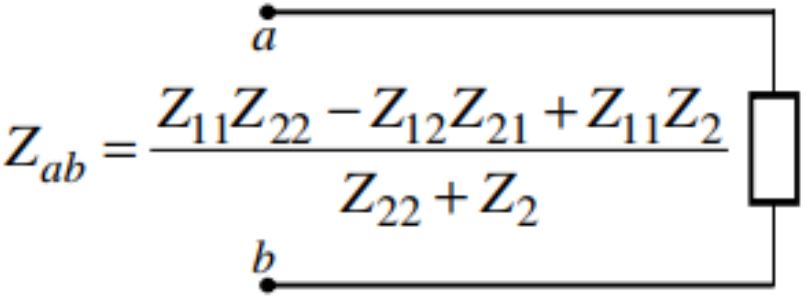


$$\mathbf{A} = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix}$$

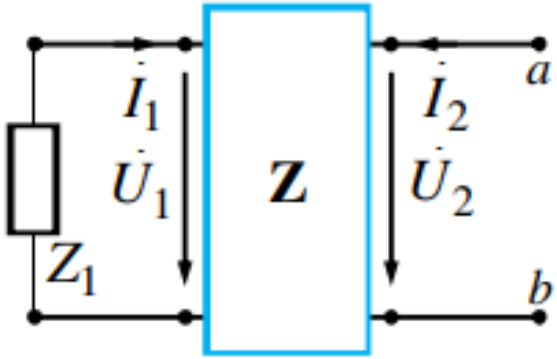


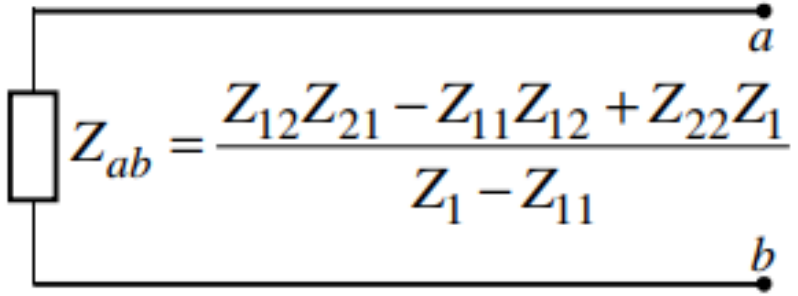






$$\mathbf{Z} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}$$

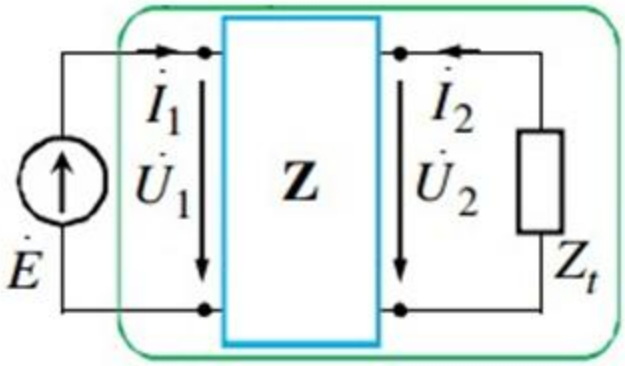




VD2

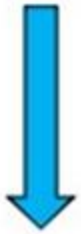
$$\dot{E} = 220\,\text{V};\ Z_t = j50\ \Omega;\ \mathbf{Z} = \begin{bmatrix} 10 & j20 \\ j20 & 40 \end{bmatrix}\ \Omega.$$

Cách 4

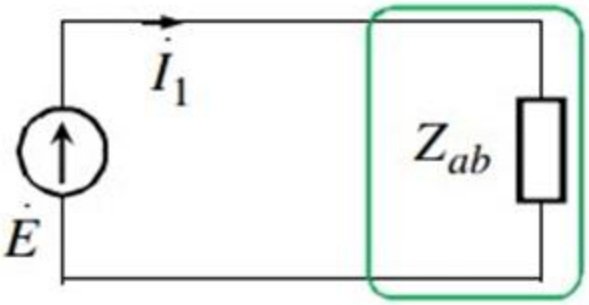


$$Z_{ab} = \frac{Z_{11}Z_{22} - Z_{12}Z_{21} + Z_{11}Z_t}{Z_{22} + Z_t} =$$

$$= \frac{10.40 - j20.j20 + 10.j50}{40 + j50} = 13,90 - j4,88\ \Omega$$



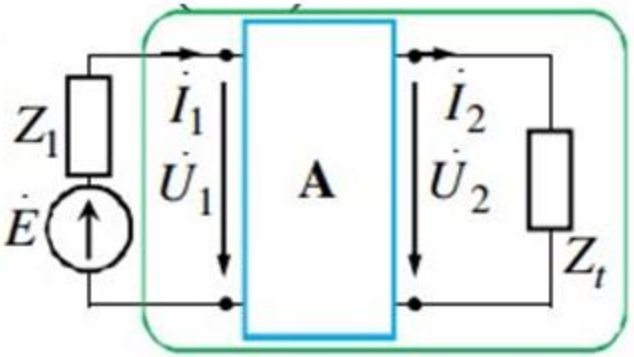
$$\dot{I}_1 = \frac{\dot{E}}{Z_{ab}} = \frac{220}{13,90 - j4,88} = \boxed{14,09 + j4,94\ \text{A}}$$



VD3

$$\dot{E} = 220\,\text{V}; \quad Z_1 = 20\,\Omega; \; Z_t = j50\;\Omega; \quad \mathbf{A} = \begin{bmatrix} 3 & 200 \\ 0,04 & 3 \end{bmatrix}.$$

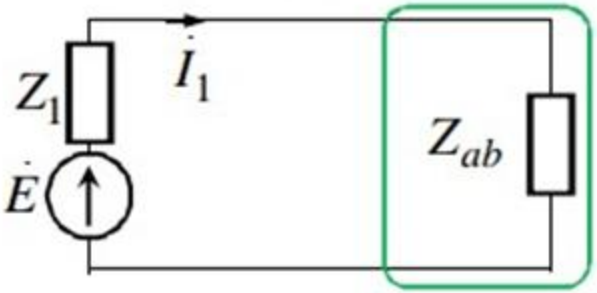
Cách 3



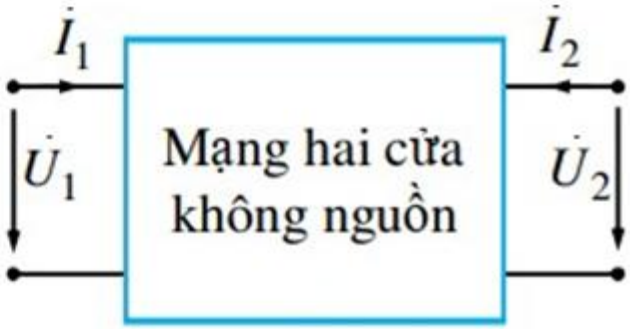
$$Z_{ab} = \frac{A_{11}Z_t + A_{12}}{A_{21}Z_t + A_{22}} = \frac{3(j50)+200}{0,04(j50)+3} = 69,23 + j3,85\;\Omega$$

$$\dot{I}_1 = \frac{\dot{E}}{Z_1 + Z_{ab}} = \frac{220}{20+69,23+j3,85}$$

$$= \boxed{2,46 - j0,11\;\text{A}}$$



2.7. Hàm truyền đạt



Hàm truyền đạt áp: $K_u = \dfrac{\dot{U}_2}{\dot{U}_1}$

Hàm truyền đạt dòng: $K_i = \dfrac{\dot{I}_2}{\dot{I}_1}$

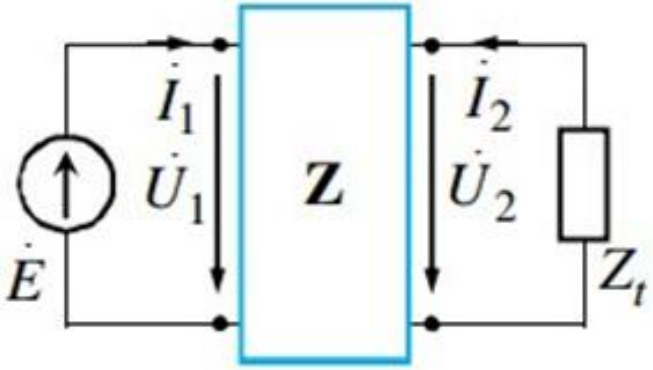
Hàm truyền đạt áp dòng: $K_{ui} = \dfrac{\dot{U}_2}{\dot{I}_1}$

VD1

$$Z = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix}; \dot{E} = 220\,\text{V}$$

$$Z_t = 15 + j25\,\Omega$$

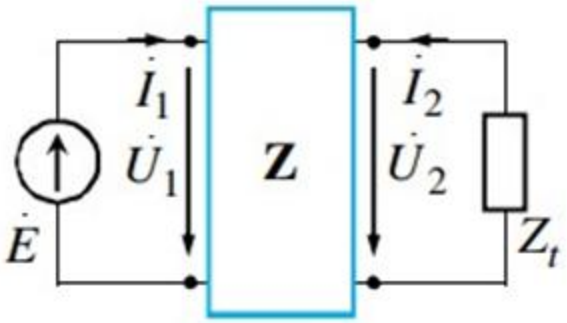
Tính K_u, K_i, K_{ui}.



VD1

$$Z = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix}; \dot{E} = 220\,\text{V}; Z_t = 15 + j25\,\Omega$$

Tính K_u, K_i, K_{ui}.



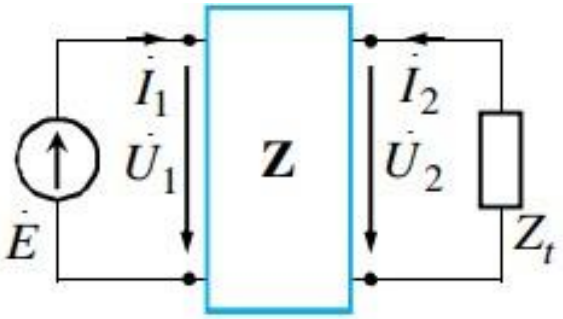
$$\begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2 \end{cases}$$
$$\dot{U}_1 = \dot{E}$$
$$\dot{U}_2 = -Z_t\dot{I}_2$$

$$\rightarrow \begin{cases} \dot{E} = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ -Z_t\dot{I}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2 \end{cases} \rightarrow \begin{cases} \dot{I}_1 = \dfrac{Z_{22} + Z_t}{Z_{11}Z_{22} - Z_{12}Z_{21} + Z_{11}Z_t}\dot{E} \\ \dot{I}_2 = \dfrac{-Z_{21}}{Z_{11}Z_{22} - Z_{12}Z_{21} + Z_{11}Z_t}\dot{E} \end{cases}$$

VD1

$$Z=\begin{bmatrix}30 & 20\\ 20 & 50\end{bmatrix};\ \dot{E}=220\,\text{V};\ Z_t=15+j25\,\Omega$$

Tính K_u, K_i, K_{ui}.



$$\dot{I}_1=\frac{Z_{22}+Z_t}{Z_{11}Z_{22}-Z_{12}Z_{21}+Z_{11}Z_t}\dot{E}$$

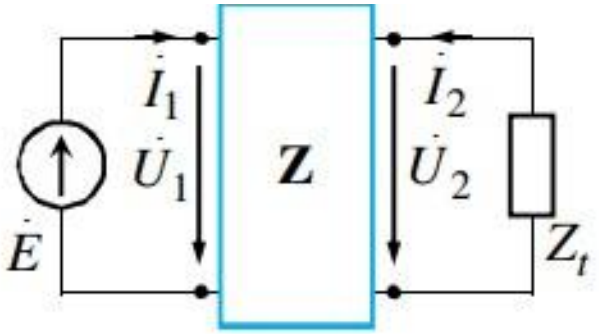
$$\left.\begin{aligned}\dot{I}_2&=\frac{-Z_{21}}{Z_{11}Z_{22}-Z_{12}Z_{21}+Z_{11}Z_t}\dot{E}\\ \dot{U}_2&=-Z_t\dot{I}_2\end{aligned}\right\}\rightarrow \dot{U}_2=\frac{Z_{21}Z_t}{Z_{11}Z_{22}-Z_{12}Z_{21}+Z_{11}Z_t}\dot{E}$$

$$\rightarrow K_u=\frac{\dot{U}_2}{\dot{U}_1}=\frac{Z_{21}Z_t}{Z_{11}Z_{22}-Z_{12}Z_{21}+Z_{11}Z_t}=\boxed{0,28+j0,19}$$

VD1

$$Z=\begin{bmatrix}30 & 20\\ 20 & 50\end{bmatrix};\ \dot{E}=220\,\text{V};\ Z_t=15+j25\,\Omega$$

Tính K_u, K_i, K_{ui}.



$$\dot{I}_1=\frac{Z_{22}+Z_t}{Z_{11}Z_{22}-Z_{12}Z_{21}+Z_{11}Z_t}\dot{E}$$

$$\dot{I}_2=\frac{-Z_{21}}{Z_{11}Z_{22}-Z_{12}Z_{21}+Z_{11}Z_t}\dot{E}$$

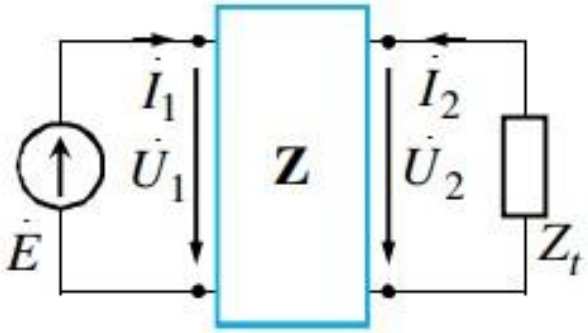
$$K_i=\frac{\dot{I}_2}{\dot{I}_1}$$

$$\rightarrow K_i=\frac{-Z_{21}}{Z_{22}+Z_t}=\boxed{-0,27+j0,10}$$

VD1

$$Z=\begin{bmatrix}30 & 20\\ 20 & 50\end{bmatrix};\ \dot{E}=220\,\text{V};\ Z_t=15+j25\,\Omega$$

Tính K_u, K_i, K_{ui}.



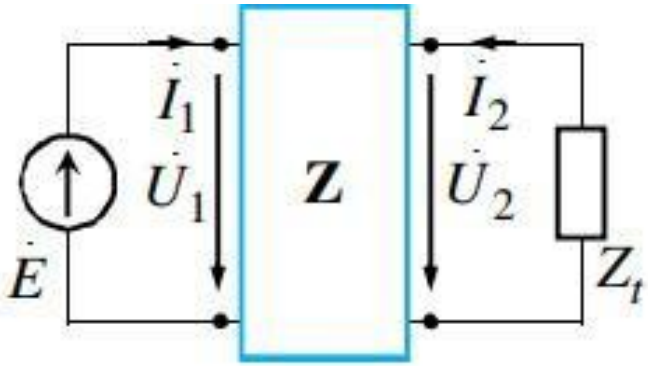
$$\left.\begin{aligned}\dot{I}_1&=\frac{Z_{22}+Z_t}{Z_{11}Z_{22}-Z_{12}Z_{21}+Z_{11}Z_t}\dot{E}\\ \dot{I}_2&=\frac{-Z_{21}}{Z_{11}Z_{22}-Z_{12}Z_{21}+Z_{11}Z_t}\dot{E}\\ K_{ui}&=\frac{\dot{U}_2}{\dot{I}_1},\quad \dot{U}_2=-Z_t\dot{I}_2\end{aligned}\right\}\rightarrow K_{ui}=\frac{Z_{21}Z_t}{Z_{22}+Z_t}$$

$$=\boxed{6,60+j5,15\ \Omega}$$

VD2

$\dot{E} = 380\,\text{V}; Z_t = 15 + j25\,\Omega;$

$K_u = 0,28 + j0,19;$ Tính U_2?



$$\left.\begin{aligned} K_u &= \frac{\dot{U}_2}{\dot{U}_1} \\ \dot{U}_1 &= \dot{E} \end{aligned}\right\} \rightarrow \dot{U}_2 = K_u \dot{E} = (0,28 + j0,19)380$$

$$= 107,7 + j70,5\ \text{V}$$

$$\rightarrow \boxed{U_2 = 128,7\,\text{V}}$$