KUTUB EMPAT

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Prodi S1-Sistem Komputer

Fakultas Teknik Elektro

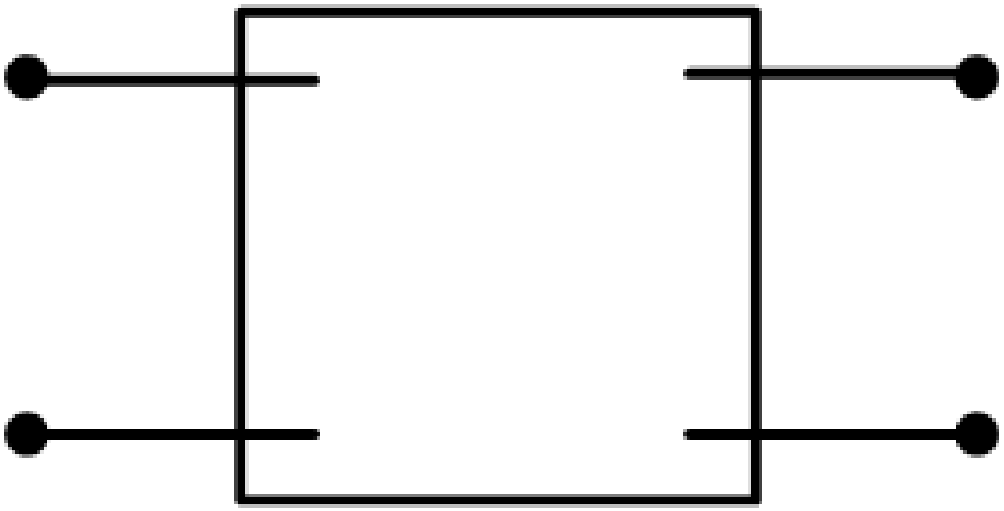
Universitas Telkom - 2016

Kutub Empat

Salah satu aplikasi penting dari konsep *network function* adalah pada jaringan dimana sinyal input dan output diukur pada pasangan terminal yang berbeda.

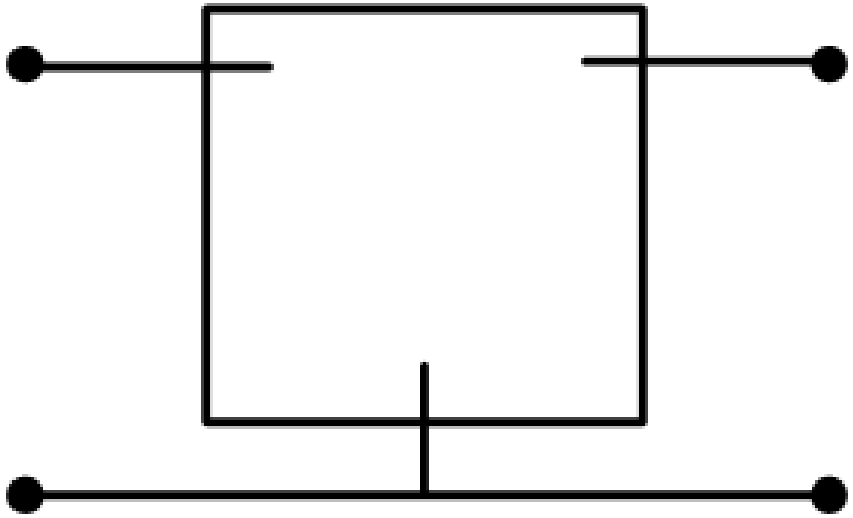
Bentuk umum :

Jaringan 2 port dengan 4 terminal



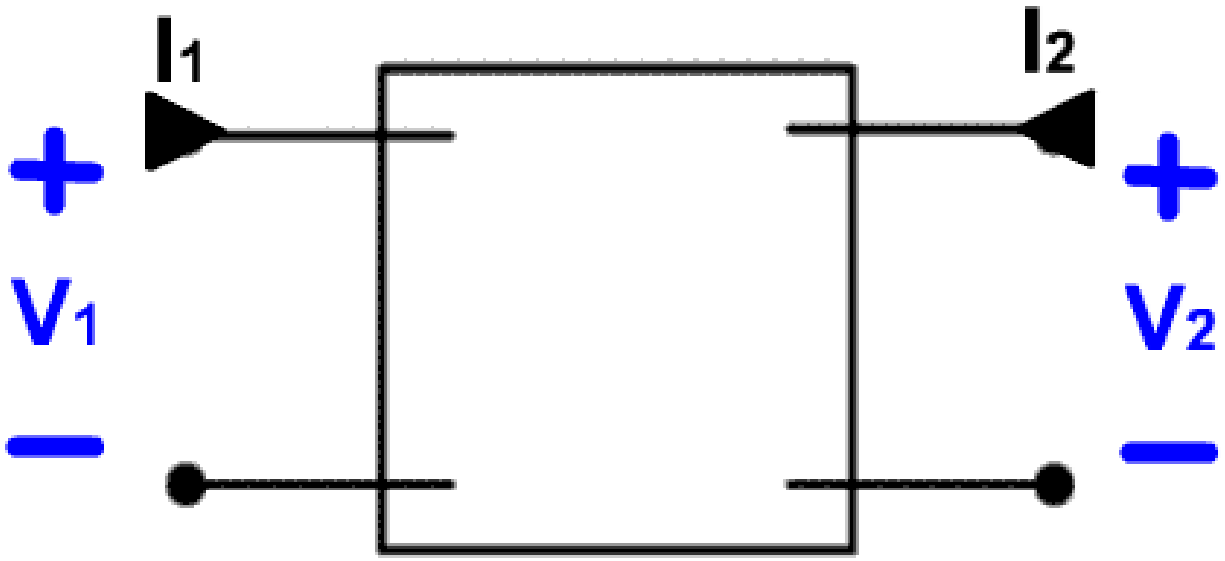
Kutub Empat

Jaringan 2 port dengan 3 terminal



1. Parameter Z
2. Parameter Y
3. Parameter hybrid
4. Parameter ABCD

Parameter Z



Misalkan : I_1 dan I_2 adalah input

V_1 dan V_2 adalah output

Maka persamaan umum :

$$V_1 = Z_{11}I_1 + Z_{12}I_2$$

$$V_2 = Z_{21}I_1 + Z_{22}I_2$$

Parameter Z

Jika port 2 open circuit ($I_2 = 0$), maka :

$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0}$$

$$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0}$$

Jika port 1 open circuit ($I_1 = 0$), maka :

$$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0}$$

$$Z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0}$$

Parameter Z

Impedansi yang dihasilkan sebagai impedansi *open circuit* atau parameter *open circuit* atau parameter Z.

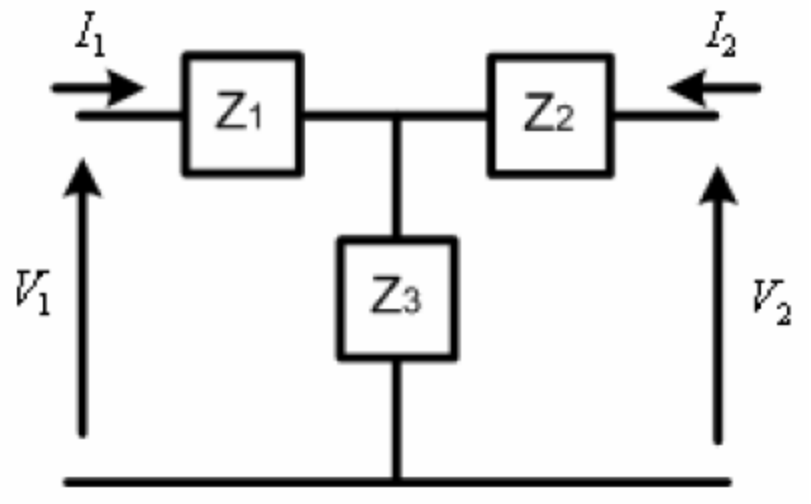
Z_{11} = impedansi port primer ketika port sekunder *open circuit*

Z_{22} = impedansi port sekunder ketika port primer *open circuit*

$Z_{12} = Z_{21}$ = impedansi transfer dimana perbandingan tegangan di satu port dibandingkan arus di port lainnya.

Contoh soal :

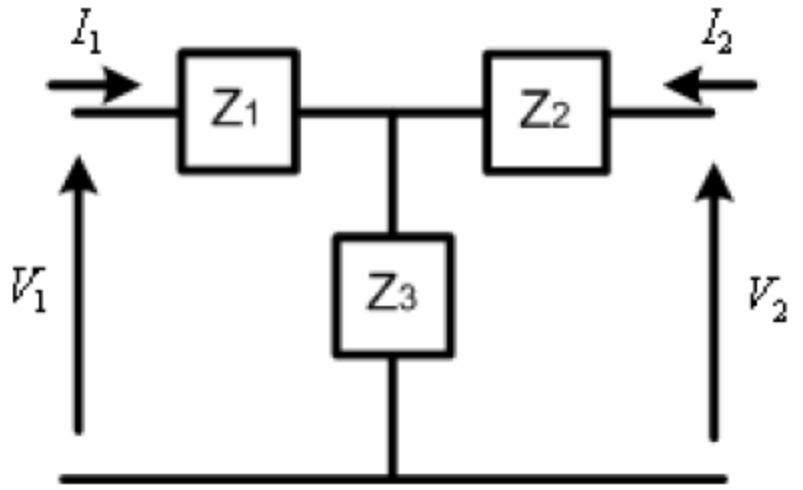
Tentukan parameter Z !



Parameter Z

Contoh soal :

Tentukan parameter Z !



Ketika port 2 OC ($I_2 = 0$), maka :

$$\frac{V_1}{I_1} = Z_1 + Z_3$$

$$\frac{V_2}{I_1} = Z_3$$

Ketika port 1 OC ($I_1 = 0$), maka :

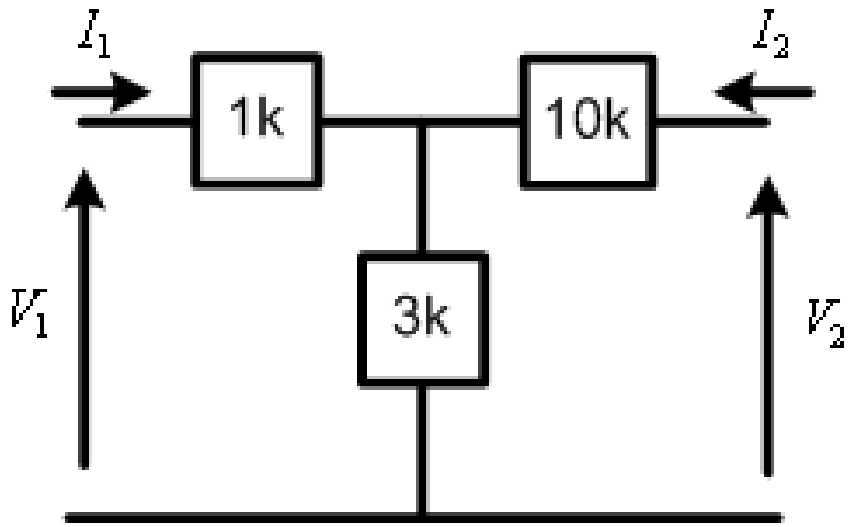
$$\frac{V_2}{I_2} = Z_2 + Z_3$$

$$\frac{V_1}{I_2} = Z_3$$

Parameter Z

Contoh soal :

Tentukan parameter Z !



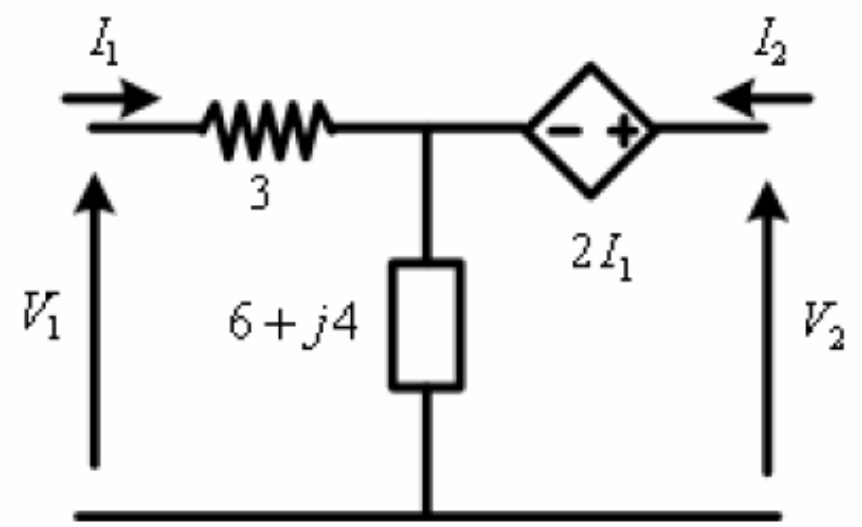
$$V_1 = (1k + 3k)I_1 + 3kI_2 = 4kI_1 + 3kI_2$$
$$V_2 = (10k + 3k)I_2 + 3kI_1 = 3kI_1 + 13kI_2$$

$$Z_{11} = 4k$$
$$Z_{12} = 3k$$
$$Z_{21} = 3k$$
$$Z_{22} = 13k$$

Parameter Z

Contoh soal :

Tentukan parameter Z !



$$V_1 = (3+6+j4)I_1 + (6+j4)I_2$$

$$V_1 = (9+j4)I_1 + (6+j4)I_2$$

$$V_2 = 2I_1 + (6+j4)I_2 + (6+j4)I_1$$

$$V_2 = (8+j4)I_1 + (6+j4)I_2$$

$$Z_{11} = 9+j4$$

$$Z_{12} = 6+j4$$

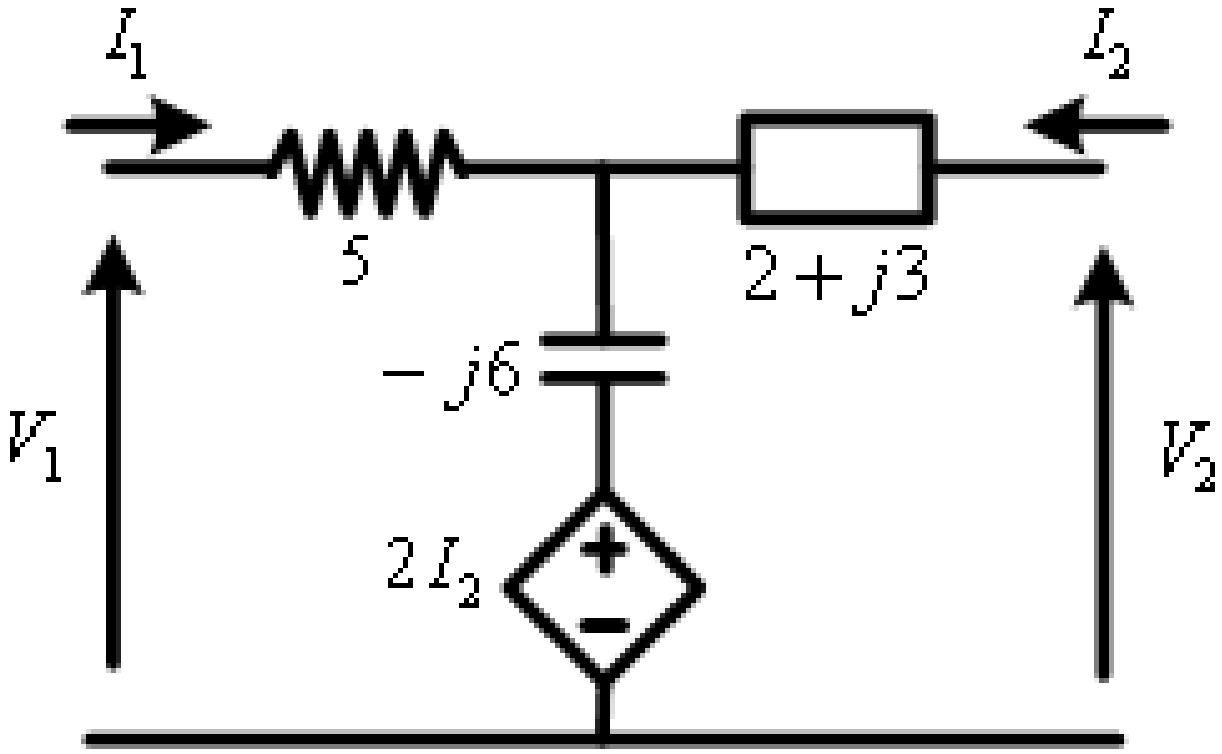
$$Z_{21} = 8+j4$$

$$Z_{22} = 6+j4$$

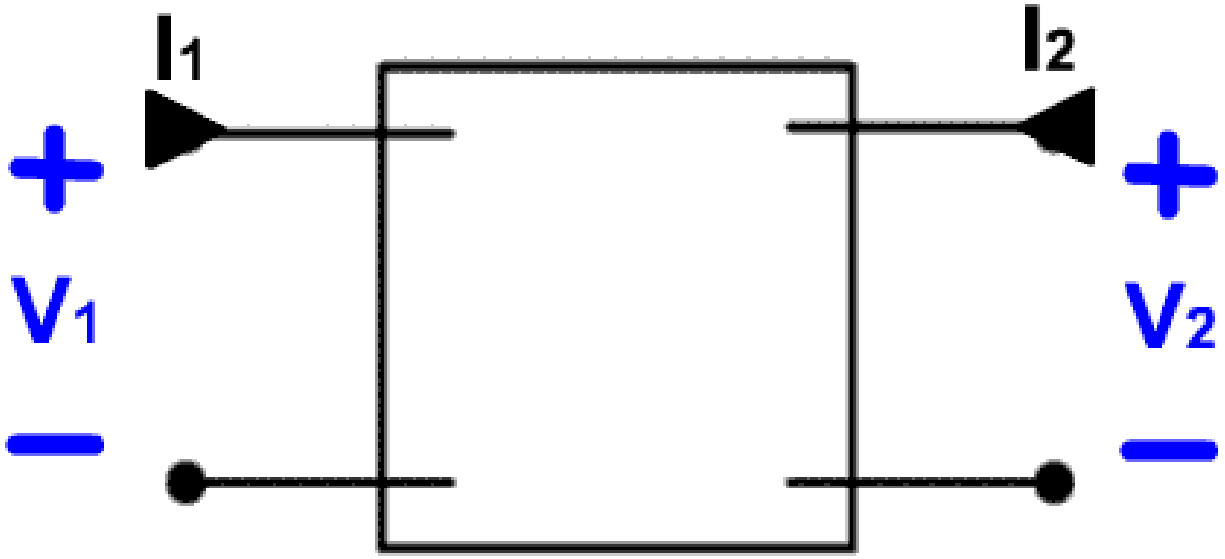
Parameter Z

Latihan

Tentukan parameter Z !



Parameter Y



Misalkan : V_1 dan V_2 adalah input

I_1 dan I_2 adalah output

Maka :

$$I_1 = Y_{11}V_1 + Y_{12}V_2$$

$$I_2 = Y_{21}V_1 + Y_{22}V_2$$

Parameter Y

Jika port 2 open circuit ($I_2 = 0$), maka :

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0}$$

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0}$$

Jika port 1 open circuit ($I_1 = 0$), maka :

$$Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0}$$

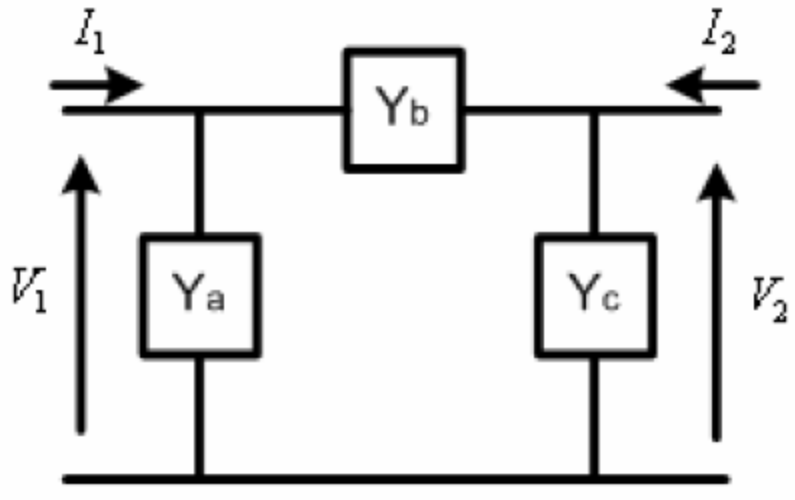
$$Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$$

Parameter Y

Admitansi yang dihasilkan sebagai admitansi *short circuit* atau parameter *short circuit* atau parameter Y.

Contoh soal :

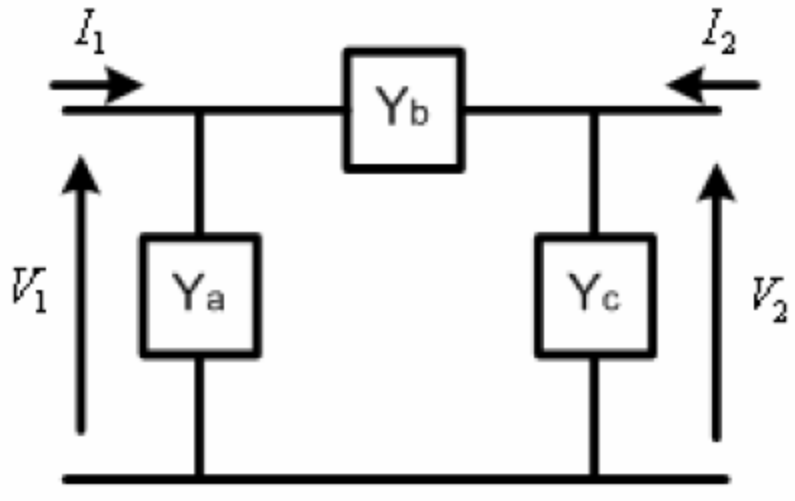
Tentukan parameter Y !



Parameter Y

Contoh soal :

Tentukan parameter Y !



Ketika port 2 SC ($V_2 = 0$), maka :

$$\frac{I_1}{V_1} = Y_a + Y_b$$

$$\frac{I_2}{V_1} = -Y_b$$

Ketika port 1 SC ($V_1 = 0$), maka :

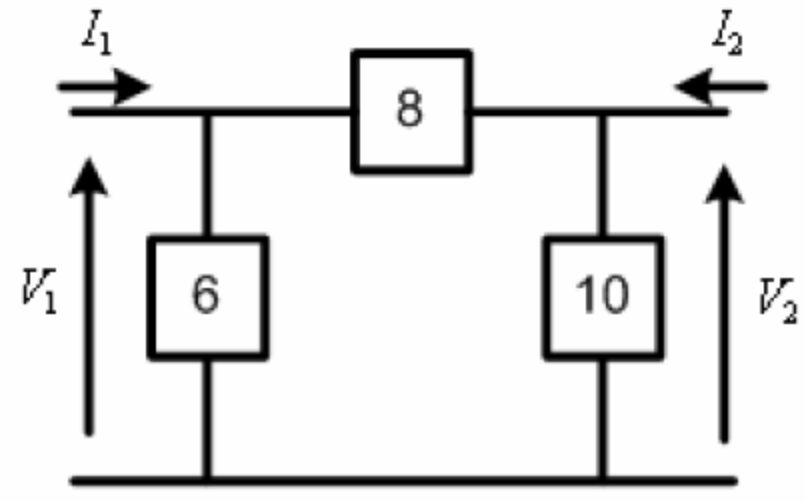
$$\frac{I_1}{V_2} = -Y_b$$

$$\frac{I_2}{V_2} = Y_b + Y_c$$

Parameter Y

Contoh soal :

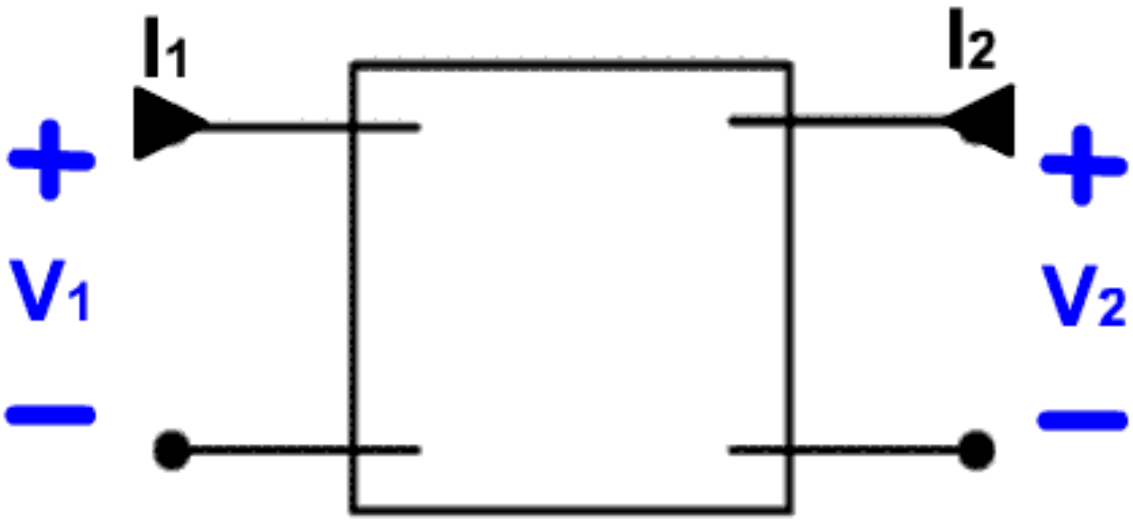
Tentukan parameter Y !



$$I_1 = 14V_1 - 8V_2$$
$$I_2 = -8V_1 + 18V_2$$

$$Y_{11} = 14$$
$$Y_{12} = -8$$
$$Y_{21} = -8$$
$$Y_{22} = 18$$

Parameter Hybrid *h*



Misalkan : I_1 dan V_2 adalah input

V_1 dan I_2 adalah output

Maka :

$$V_1 = h_{11}I_1 + h_{12}V_2$$

$$I_2 = h_{21}I_1 + h_{22}V_2$$

Parameter Hybrid *h*

Jika port 2 short circuit ($V_2 = 0$), sehingga :

$$h_{11} = \left.\frac{V_1}{I_1}\right|_{V_2=0}$$

$$h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0}$$

Jika port 1 open circuit ($I_1 = 0$), sehingga :

$$h_{12} = \left.\frac{V_1}{V_2}\right|_{I_1=0}$$

$$h_{22} = \left.\frac{I_2}{V_2}\right|_{I_1=0}$$

Parameter Hybrid *g*

Misalkan : V_1 dan I_2 adalah input

I_1 dan V_2 adalah output

Maka :

$$I_1 = g_{11}V_1 + g_{12}I_2$$

$$V_2 = g_{21}V_1 + g_{22}I_2$$

Jika port 2 open circuit ($I_2 = 0$), sehingga :

$$g_{11} = \left.\frac{I_1}{V_1}\right|_{I_2=0}$$

$$g_{21} = \left.\frac{V_2}{V_1}\right|_{I_2=0}$$

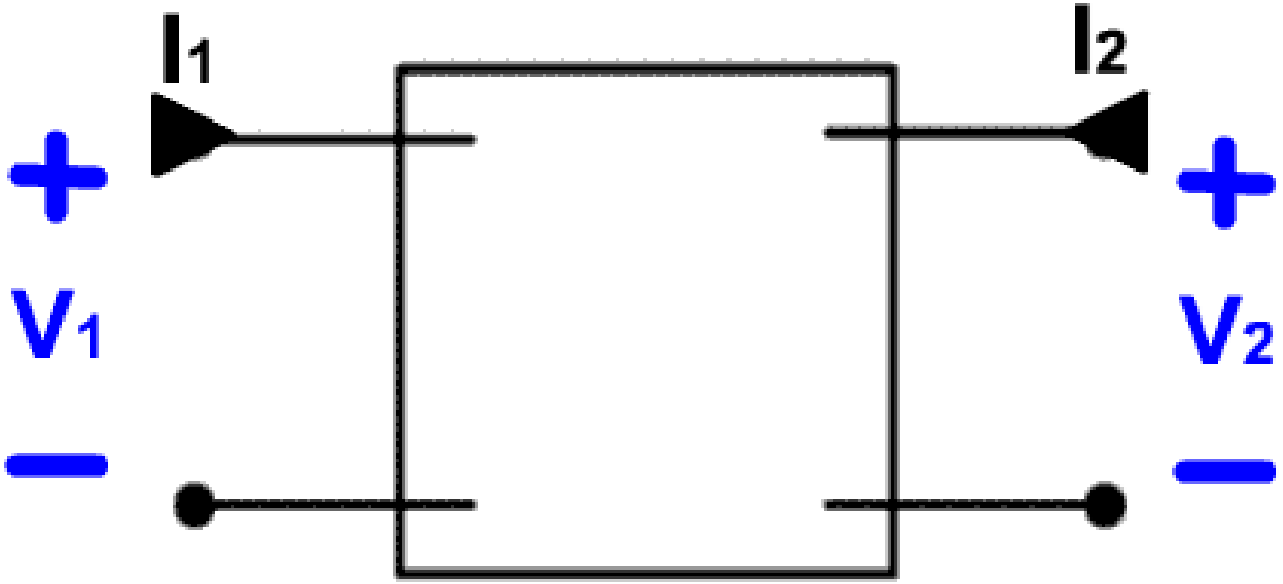
Parameter Hybrid *g*

Jika port 1 short circuit ($V_1 = 0$), sehingga :

$$g_{12} = \left.\frac{I_1}{I_2}\right|_{V_1=0}$$

$$g_{22} = \left.\frac{V_2}{I_2}\right|_{V_1=0}$$

Parameter ABCD



Parameter ini penting untuk *engineering* transmisi sebab disisi primer (pengirim) terdiri dari variable V_1 dan I_1, sedangkan disisi sekunder (penerima) terdiri dari variabel V_2 dan - I_2 (negatif I_2 karena arus masuk ke beban penerima).

Parameter ABCD

Misalkan : V_2 dan I_2 adalah input

V_1 dan I_1 adalah output

Maka :

$$V_1 = AV_2 - BI_2$$

$$I_1 = AV_2 - BI_2$$

Jika port 2 open circuit ($I_2 = 0$), sehingga :

$$A = \left.\frac{V_1}{V_2}\right|_{I_2=0}$$

$$C = \left.\frac{I_1}{V_2}\right|_{I_2=0}$$

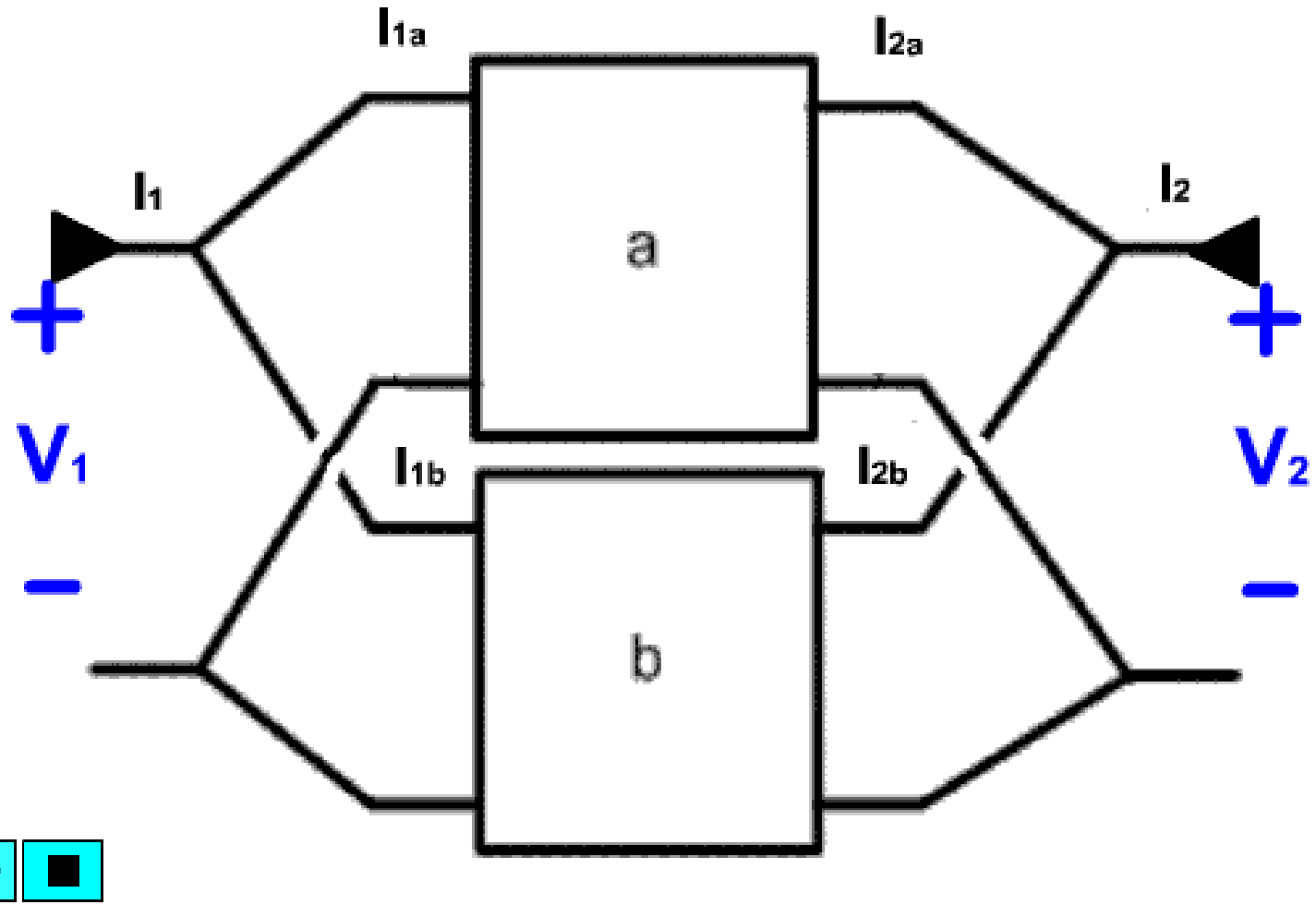
Parameter ABCD

Jika port 2 short circuit ($V_2 = 0$), sehingga :

$$B = \left.\frac{V_1}{-I_2}\right|_{V_2=0}$$

$$D = \left.\frac{I_1}{-V_2}\right|_{V_2=0}$$

Koneksi Paralel



Koneksi Paralel

$$I_{1a} = Y_{11a}V_{1a} + Y_{12a}V_{2a}$$
$$I_{2a} = Y_{21a}V_{1a} + Y_{22a}V_{2a}$$
$$I_{1b} = Y_{11b}V_{1b} + Y_{12b}V_{2b}$$
$$I_{2b} = Y_{21b}V_{1b} + Y_{22b}V_{2b}$$

Dimana :

$$V_1 = V_{1a} = V_{1b}$$
$$V_2 = V_{2a} = V_{2b}$$
$$I_1 = I_{1a} + I_{1b}$$
$$I_2 = I_{2a} + I_{2b}$$

Koneksi Paralel

$$I_1 = I_{1a} + I_{1b}$$

$$I_1 = Y_{11a}V_{1a} + Y_{12a}V_{2a} + Y_{11b}V_{1b} + Y_{12b}V_{2b}$$

$$I_1 = (Y_{11a} + Y_{11b})V_1 + (Y_{12a} + Y_{12b})V_2$$

$$I_2 = I_{2a} + I_{2b}$$

$$I_2 = Y_{21a}V_{1a} + Y_{22a}V_{2a} + Y_{21b}V_{1b} + Y_{22b}V_{2b}$$

$$I_2 = (Y_{21a} + Y_{21b})V_1 + (Y_{22a} + Y_{22b})V_2$$

dengan demikian :

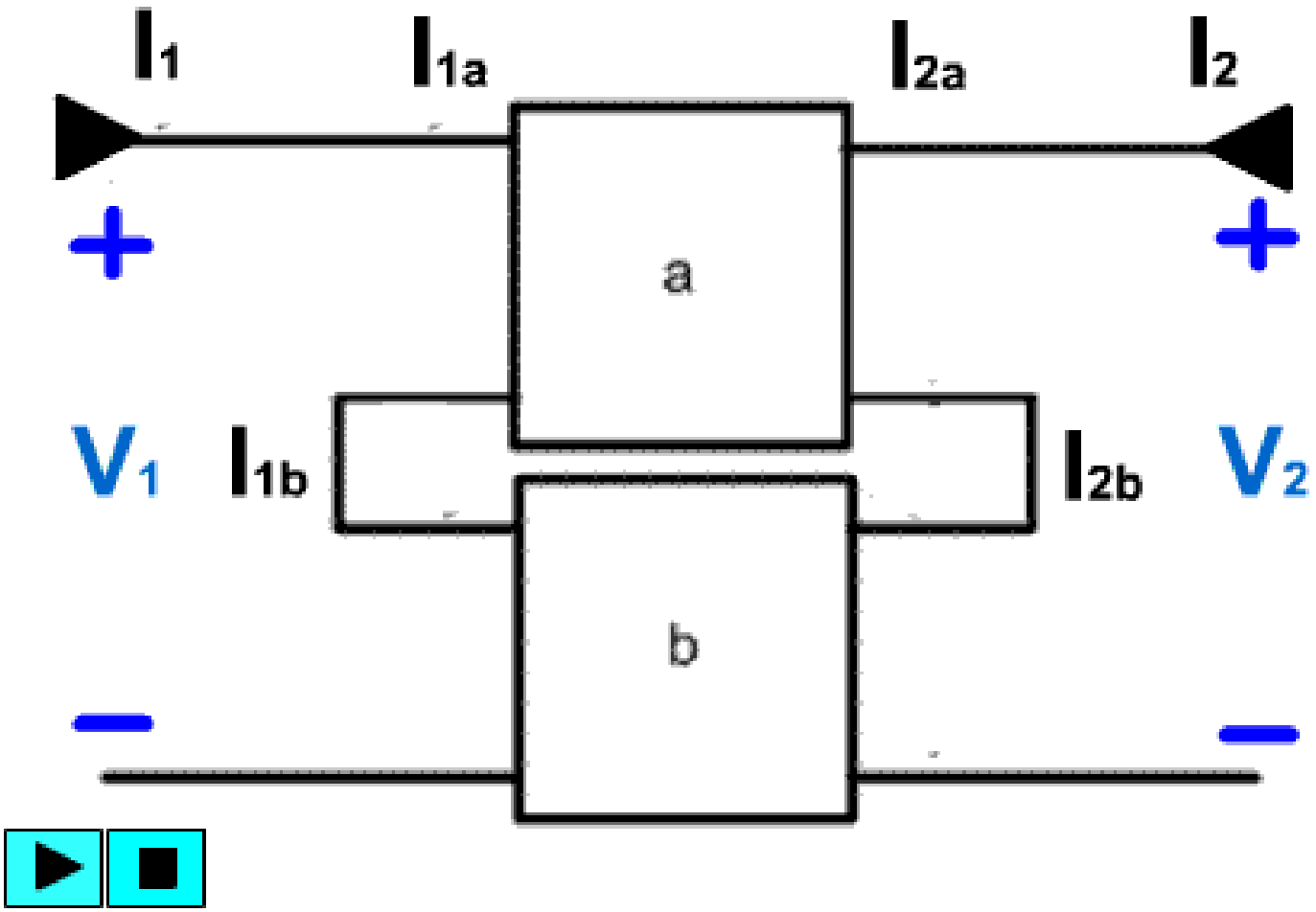
$$Y_{11} = Y_{11a} + Y_{11b}$$

$$Y_{12} = Y_{12a} + Y_{12b}$$

$$Y_{21} = Y_{21a} + Y_{21b}$$

$$Y_{22} = Y_{22a} + Y_{22b}$$

Koneksi Seri



Koneksi Seri

$$V_{1a} = Z_{11a} I_{1a} + Z_{12a} I_{2a}$$
$$V_{2a} = Z_{21a} I_{1a} + Z_{22a} I_{2a}$$
$$V_{1b} = Z_{11b} I_{1b} + Z_{12b} I_{2b}$$
$$V_{2b} = Z_{21b} I_{1b} + Z_{22b} I_{2b}$$

Dimana :

$$I_1 = I_{1a} = I_{1b}$$
$$I_2 = I_{2a} = I_{2b}$$

Koneksi Seri

$$V_1 = V_{1a} + V_{1b} = Z_{11a} I_{1a} + Z_{12a} I_{2a} + Z_{11b} I_{1b} + Z_{12b} I_{2b} = Z_{11a} I_{1a} + Z_{11b} I_{1b} + Z_{12a} I_{2a} + Z_{12b} I_{2b}$$

$$V_1 = (Z_{11a} + Z_{11b}) I_1 + (Z_{12a} + Z_{12b}) I_2$$

$$V_2 = V_{2a} + V_{2b} = Z_{21a} I_{1a} + Z_{22a} I_{2a} + Z_{21b} I_{1b} + Z_{22b} I_{2b} = Z_{21a} I_{1a} + Z_{21b} I_{1b} + Z_{22a} I_{2a} + Z_{22b} I_{2b}$$

$$V_2 = (Z_{21a} + Z_{21b}) I_1 + (Z_{22a} + Z_{22b}) I_2$$

dengan demikian :

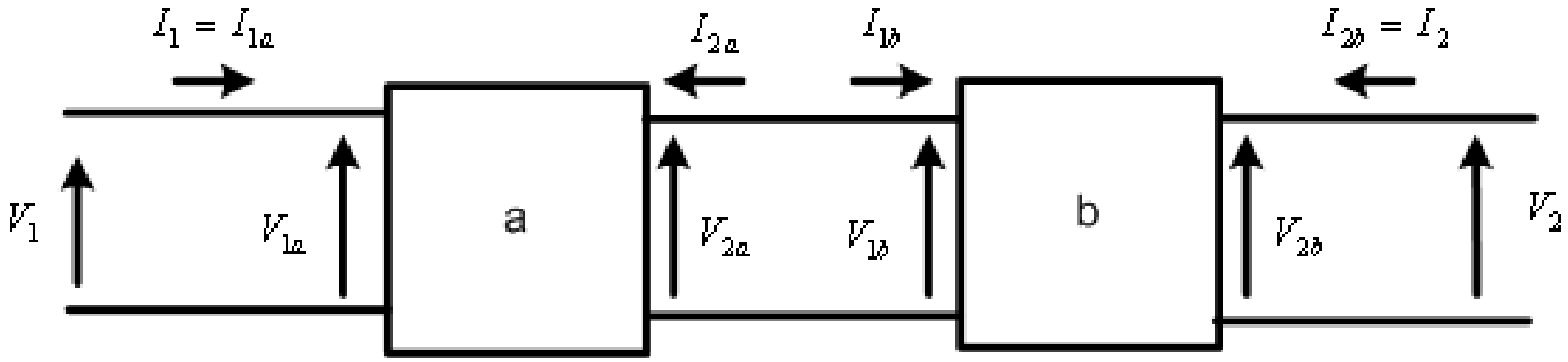
$$Z_{11} = Z_{11a} + Z_{11b}$$

$$Z_{12} = Z_{12a} + Z_{12b}$$

$$Z_{21} = Z_{21a} + Z_{21b}$$

$$Z_{22} = Z_{22a} + Z_{22b}$$

Koneksi Kaskade



$$V_1 = V_{1a} = A_a V_{2a} - B_a I_{2a} = A_a V_{1b} + B_a I_{1b} = A_a (A_b V_{2b} - B_b I_{2b}) + B_a (C_b V_{2b} - D_b I_{2b})$$

$$V_1 = (A_a A_b + B_a C_b) V_{2b} - (A_a B_b + B_a D_b) I_{2b}$$

$$I_1 = (C_a A_b + D_a C_b) V_2 - (C_a B_b + D_a D_b) I_2$$

Dimana :

$$A = A_a A_b + B_a C_b$$

$$B = A_a B_b + B_a D_b$$

$$C = C_a A_b + D_a C_b$$

$$D = C_a B_b + D_a D_b$$