Electric Circuits and Networks

Two port Networks - parallel and series connections.

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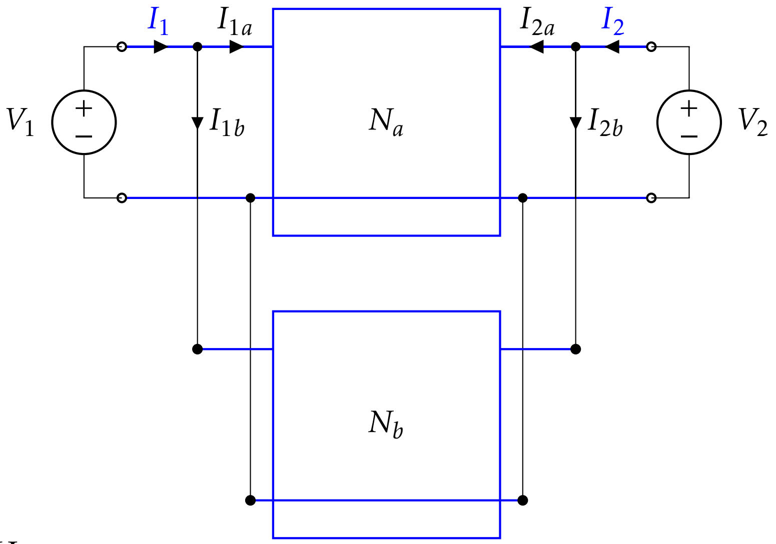
Parallel connection



Connecting N_b to N_a should not alter the port currents in N_a when a voltage source is connected to the port. We see that $I_1 = I_{1a} + I_{2a}$ and $I_2 = I_{2a} + I_{2b}$. If $V_2 = 0$, both N_a and N_b have port 2 shorted and an input voltage V_1 at port 1.

Hence,

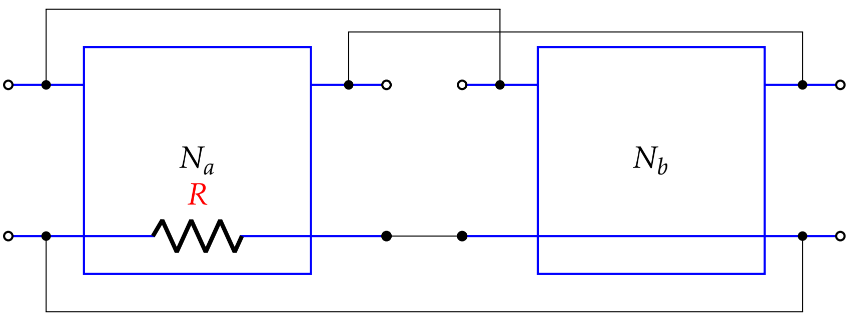
$$y_{11} = \frac{I_1}{V_1} = \frac{I_{1a} + I_{1b}}{V_1} = y_{11_a} + y_{11_b}$$

and

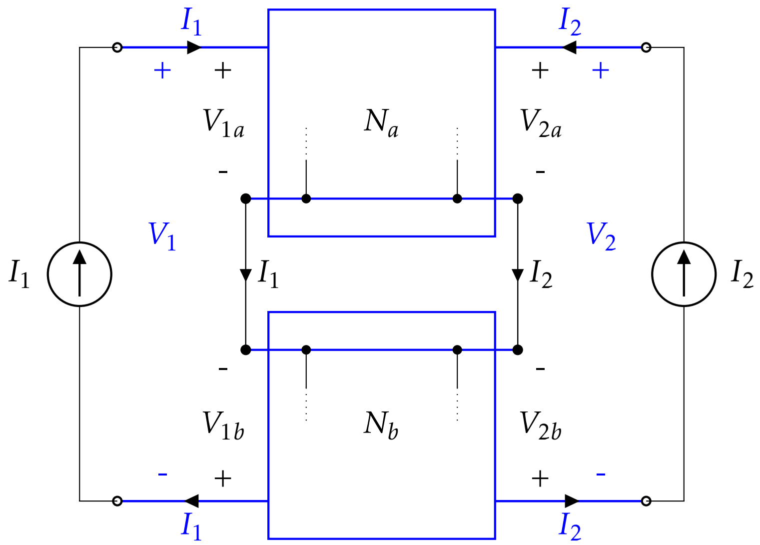
$$y_{21} = \frac{I_2}{V_1} = \frac{I_{2a} + I_{2b}}{V_1} = y_{21_a} + y_{21_b}$$

The other two parameters add in a similar fashion.

This addition will not work in the following parallel connection due to the presence of the resistor R. When N_b is connected, the resistor gets shorted out altering the y parameters of N_a.



Series connection



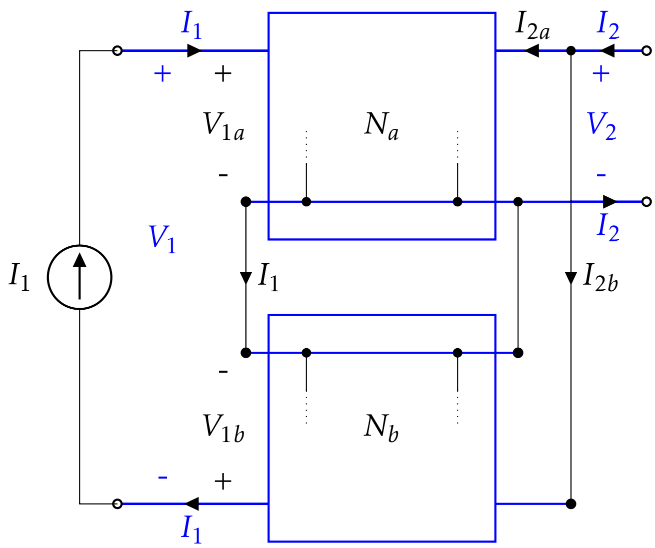
Connecting N_b to N_a should not alter the port currents in either network when a current source is connected. Note the polarities of the port voltages in N_b. The z parameters of the combined network is equal to the sum of the z parameters of N_a and N_b.

Lets say we set $I_2 = 0$ and measure z_{11} and z_{21}. We have $V_1 = V_{1a} - V_{1b}$ and $V_2 = V_{2a} - V_{2b}$. For N_b, the current I_1 leaves port 1, so that $z_{11_b} = \frac{V_{1b}}{I_{1_b}} = \frac{V_{1b}}{-I_1}$.

$$z_{11} = \frac{V_1}{I_1} = \frac{V_{1a} - V_{1b}}{I_1} = z_{11_a} + z_{11_b}$$
$$z_{21} = \frac{V_2}{I_1} = \frac{V_{2a} - V_{2b}}{I_1} = z_{21_a} + z_{21_b}$$

The other two parameters add in a similar fashion.

Series-Parallel connections



Note that $h_{11_b} = \frac{V_{1b}}{-I_1}$ and $h_{21_b} = \frac{I_{2b}}{-I_1}$. Therefore,

$$V_1 = V_{1a} - V_{1b}$$
$$I_2 = I_{2a} + I_{2b}$$
$$h_{11} = \left.\frac{V_1}{I_1}\right|_{V_2=0} = h_{11_a} + h_{11_b}$$
$$h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0}$$
$$= \frac{I_{2a} + I_{2b}}{I_1} = h_{21_a} - h_{21_b}$$

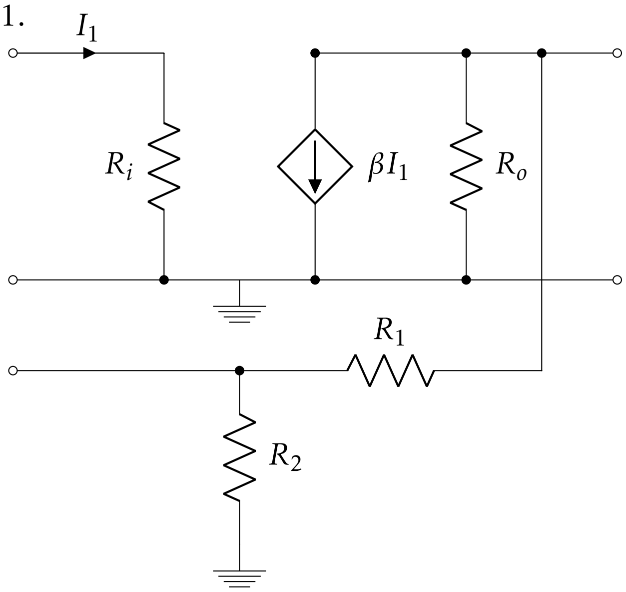
Similarly $h_{22} = h_{22_a} + h_{22_b}$ and $h_{12} = h_{12_a} - h_{12_b}$.

Parallel-series connections can be done similarly with g-parameters as the preferred parameters. They will add similar to h-parameters.

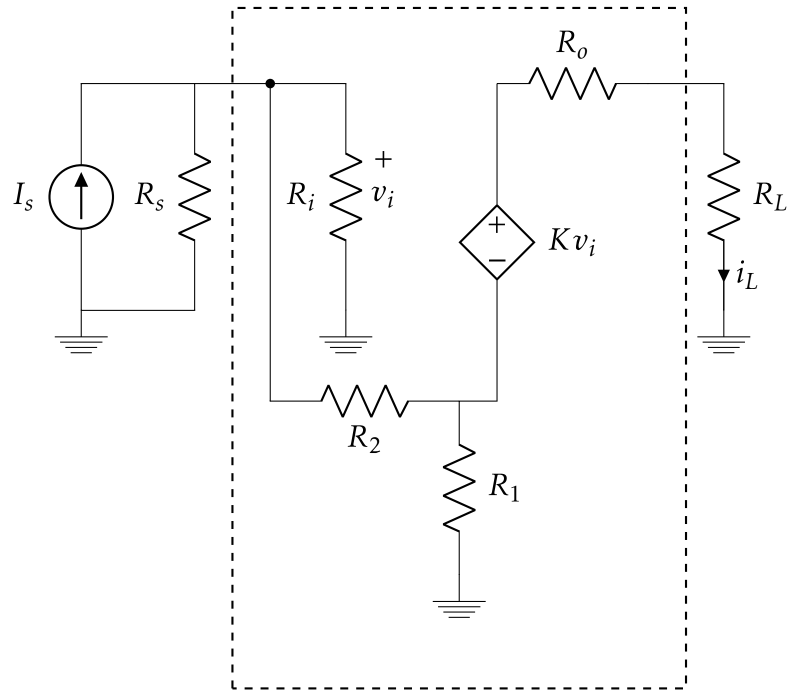
Exercises

Which parameters are most suitable for analysis of the following networks? In each case, find the parameters of the individual and combined network.

1.



2.



Get the parameters for the circuit within the dashed box and find the overall current gain.