EMPossible

Electromagnetics:

Microwave Engineering

Examples of Network Parameters

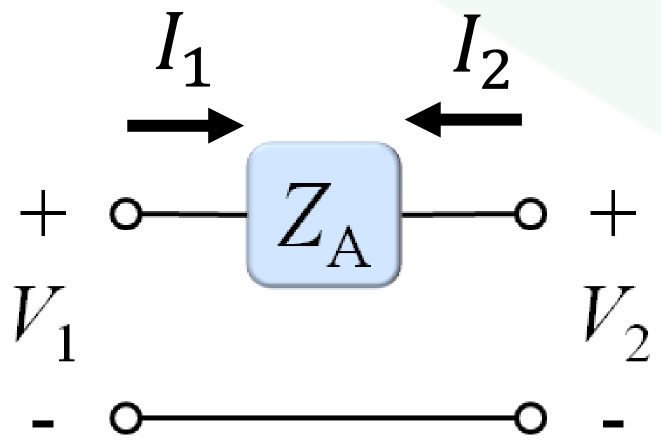
Lecture Outline

- Example #1 – Impedance and Admittance Parameters
- Example #2 – T-Network Impedance Parameters

Example #1 – Impedance and Admittance Parameters

Example #1 – Impedance and Admittance Parameters

Obtain the admittance parameters of the network shown below.

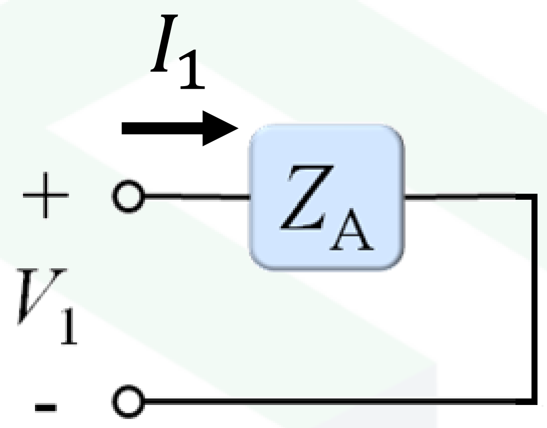


$$Y_{ij} = \left. \frac{I_i}{V_j} \right|_{\text{all other voltages zero}}$$

EMPossible

Example #1 – Impedance and Admittance Parameters

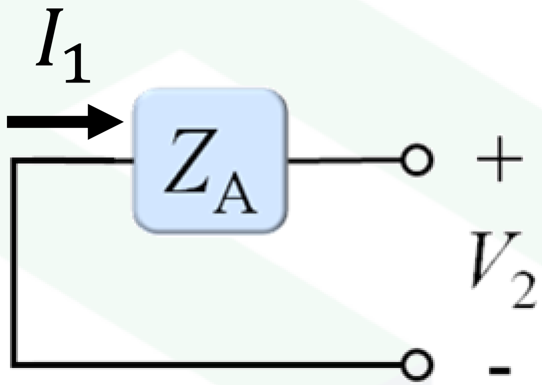
$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0}$$



$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = \frac{V_1/Z_A}{V_1} = \boxed{\frac{1}{Z_A}}$$

Example #1 – Impedance and Admittance Parameters

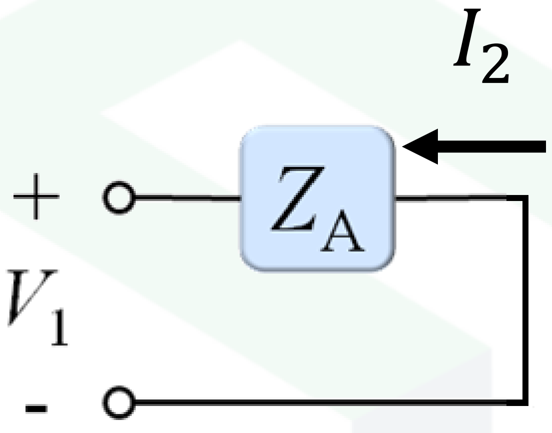
$$Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0}$$



$$Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} = \frac{-V_2/Z_A}{V_2} = \boxed{\frac{-1}{Z_A}}$$

Example #1 – Impedance and Admittance Parameters

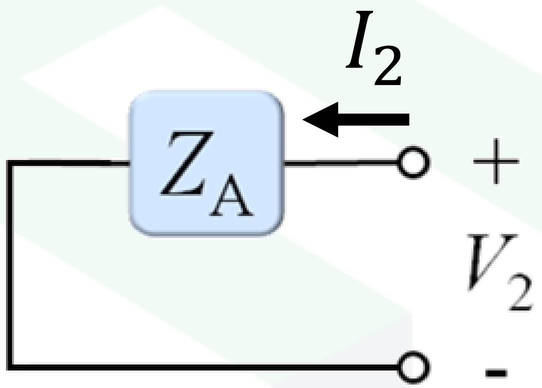
$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0}$$



$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} = \frac{-V_1/Z_A}{V_1} = \boxed{\frac{-1}{Z_A}}$$

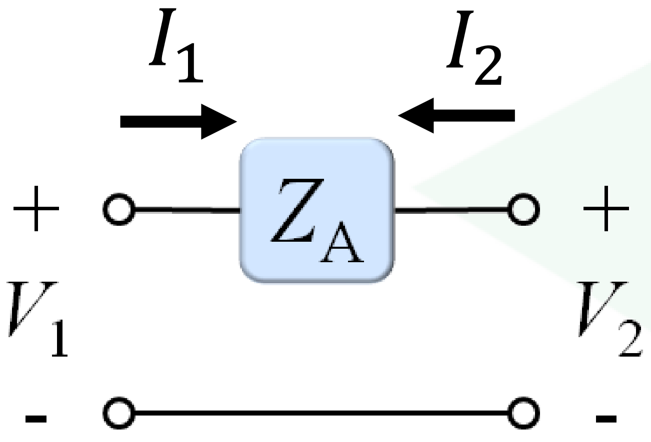
Example #1 – Impedance and Admittance Parameters

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



$$Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} = \frac{V_2/Z_A}{V_2} = \boxed{\frac{1}{Z_A}}$$

Example #1 – Impedance and Admittance Parameters

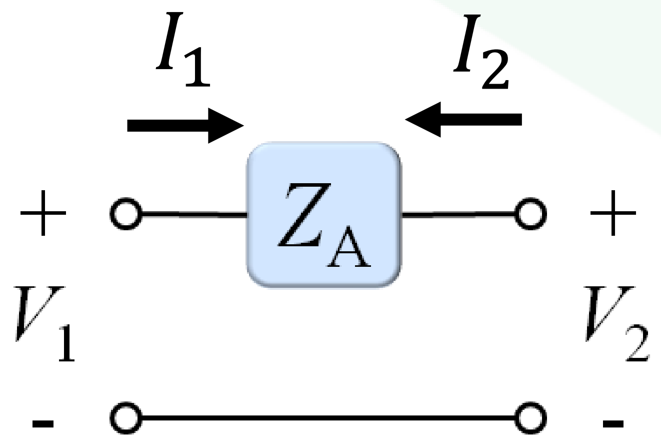


$$Y_{ij} = \left. \frac{I_i}{V_j} \right|_{\text{all other voltages zero}}$$

$$[Y] = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} = \frac{1}{Z_A} \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$$

Example #1 – Impedance and Admittance Parameters

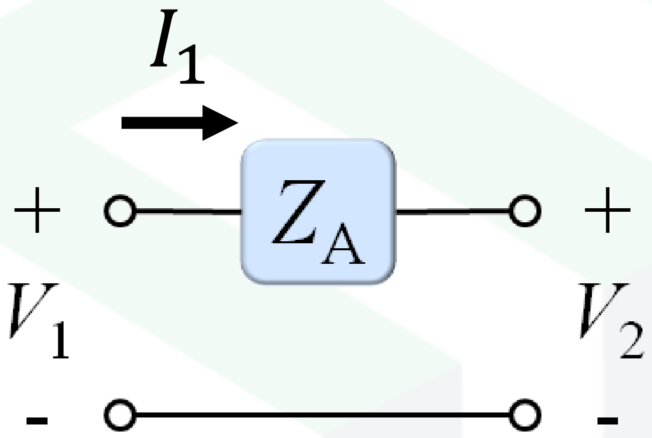
Obtain the impedance parameters of the network shown below.



$$Z_{ij} = \left.\frac{V_i}{I_j}\right|_{\text{all other currents zero}}$$

Example #1 – Impedance and Admittance Parameters

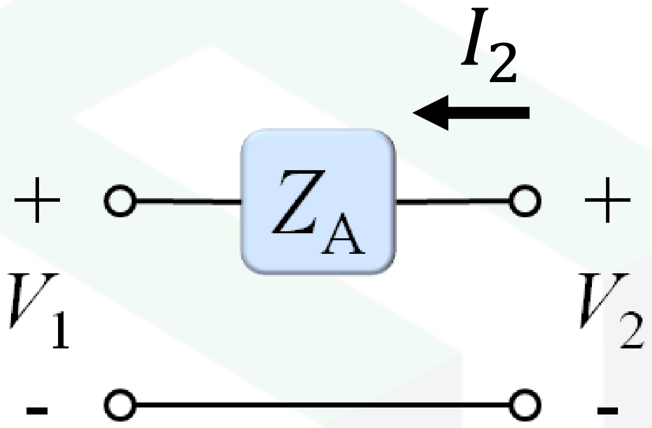
$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0}$$



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

Example #1 – Impedance and Admittance Parameters

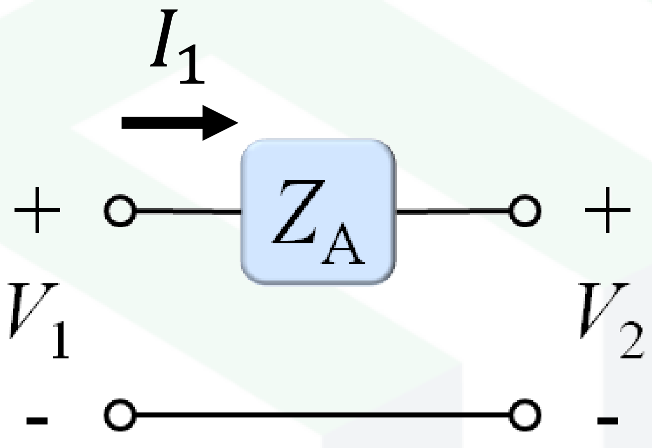
$$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0}$$



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

Example #1 – Impedance and Admittance Parameters

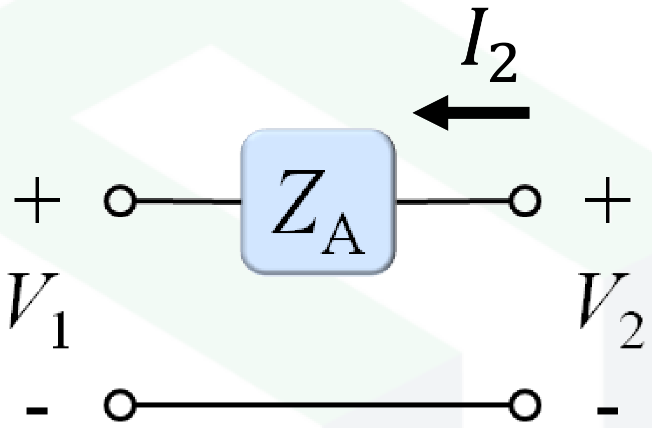
$$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0}$$



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

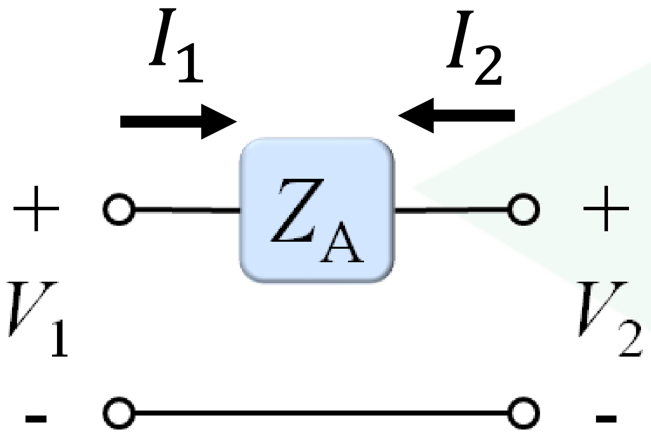
Example #1 – Impedance and Admittance Parameters

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



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

Example #1 – Impedance and Admittance Parameters



$$Z_{ij} = \left. \frac{V_i}{I_j} \right|_{\text{all other currents zero}}$$

$$[Z] = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} \infty & \infty \\ \infty & \infty \end{bmatrix}$$

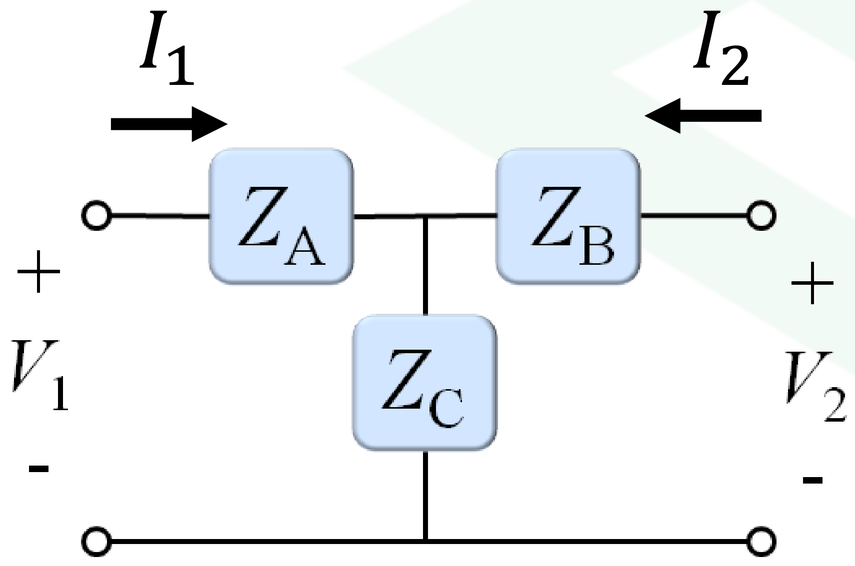
Reciprocal? Yes

Lossless? if Z_A is purely imaginary

Example #2 – T-Network Impedance Parameters

Example #2 – Impedance Parameters

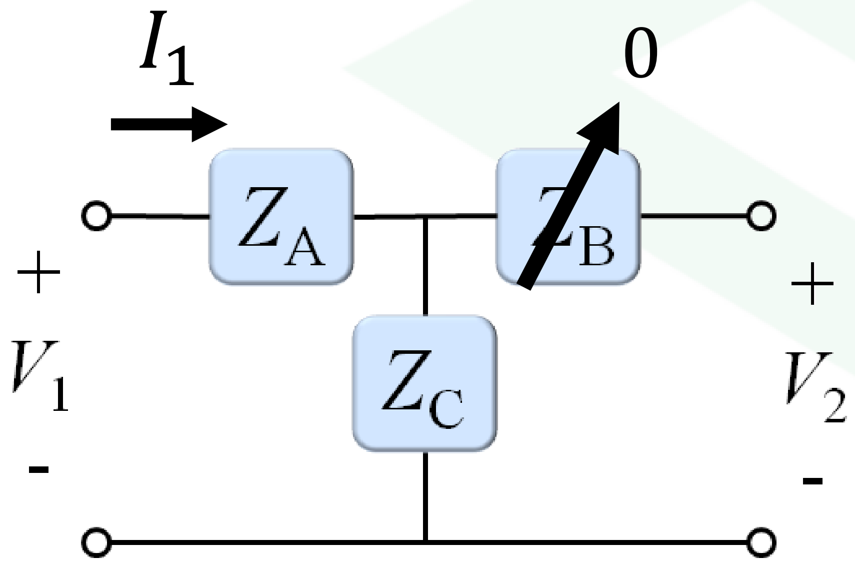
Obtain the impedance parameters of the network shown below.



$$Z_{ij} = \left.\frac{V_i}{I_j}\right|_{\text{all other currents zero}}$$

Example #2 – Impedance Parameters

Obtain the impedance parameters of the network shown below.



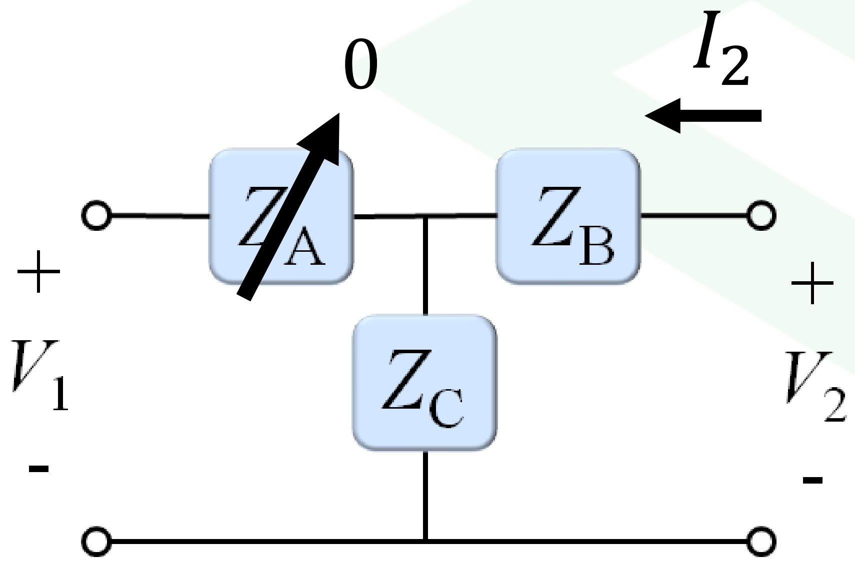
$$I_1 = \frac{V_1}{Z_A + Z_C}$$

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

$$Z_{11} = \frac{V_1}{\frac{V_1}{Z_A + Z_C}} = \boxed{Z_A + Z_C}$$

Example #2 – Impedance Parameters

Obtain the impedance parameters of the network shown below.



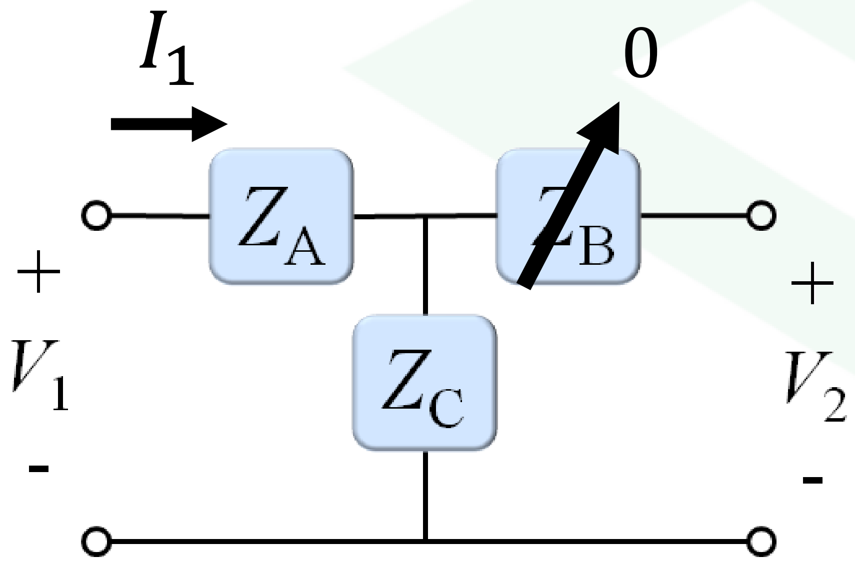
$$V_1 = I_2 Z_C$$

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

$$Z_{12} = \frac{I_2 Z_C}{I_2} = \boxed{Z_C}$$

Example #2 – Impedance Parameters

Obtain the impedance parameters of the network shown below.



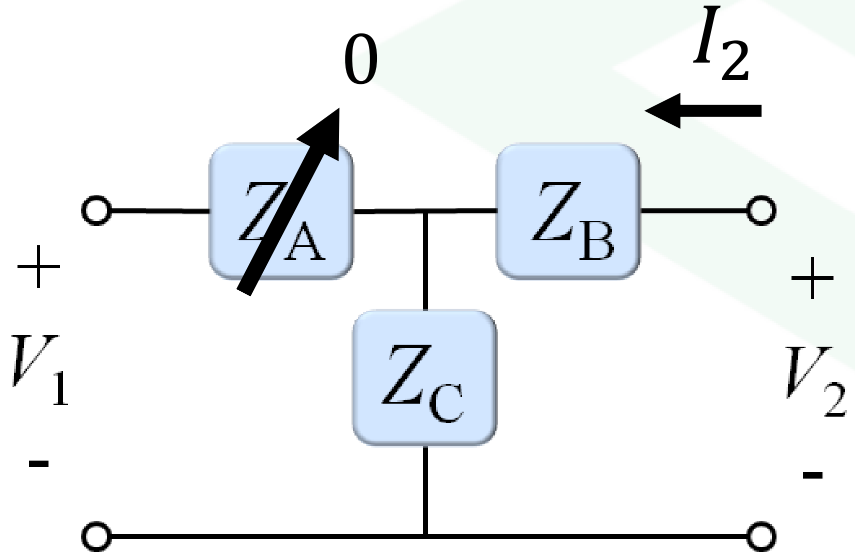
$V_2 = I_1 Z_C$

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

$$Z_{21} = \frac{I_1 Z_C}{I_1} = \boxed{Z_C}$$

Example #2 – Impedance Parameters

Obtain the impedance parameters of the network shown below.

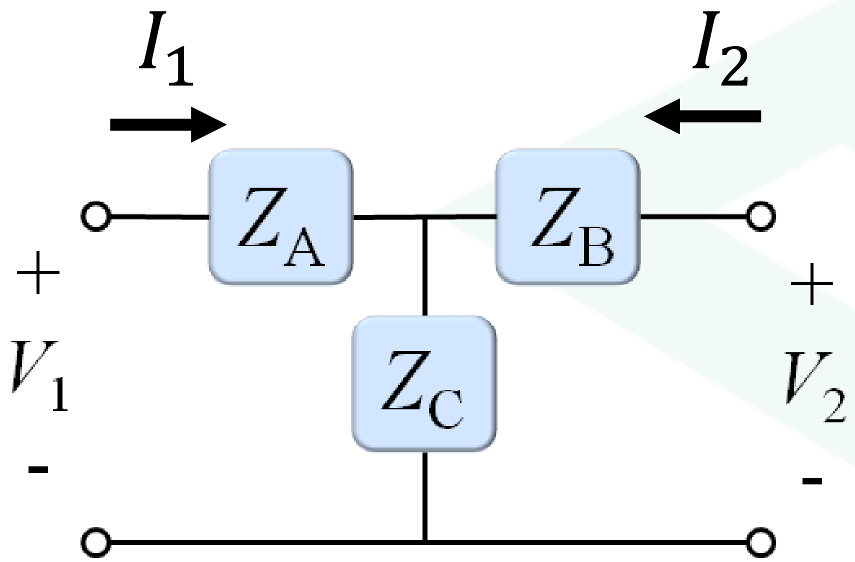


$$I_2 = \frac{V_2}{Z_B + Z_C}$$

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

$$Z_{22} = \frac{V_2}{\frac{V_2}{Z_B + Z_C}} = \boxed{Z_B + Z_C}$$

Example #2 – Impedance Parameters



$$Z_{ij} = \left.\frac{V_i}{I_j}\right|_{\text{all other currents zero}}$$

$$[Z] = \begin{bmatrix} Z_A + Z_C & Z_C \\ Z_C & Z_A + Z_C \end{bmatrix}$$

Reciprocal? Yes

Lossless? Only if $Z_A = Z_B = Z_C$ is purely reactive