



Electromagnetics:
Microwave Engineering

Examples of Network
Parameters



Lecture Outline

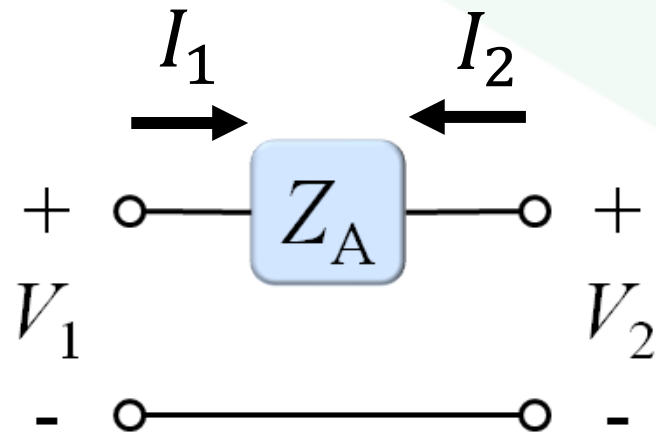
- Example #1 – Impedance and Admittance Parameters
- Example #2 – T-Network Impedance Parameters



Example #1 – Impedance and Admittance Parameters

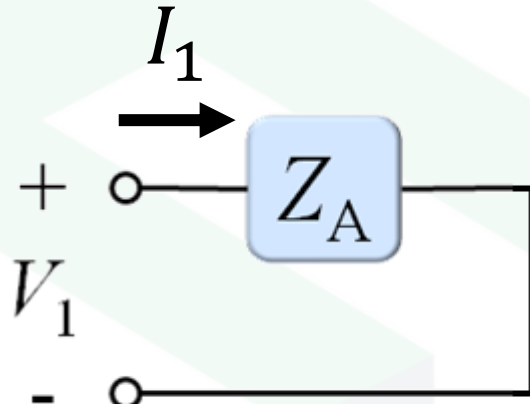
Example #1 – Impedance and Admittance Parameters

Obtain the admittance parameters of the network shown below.



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

Example #1 – Impedance and Admittance Parameters

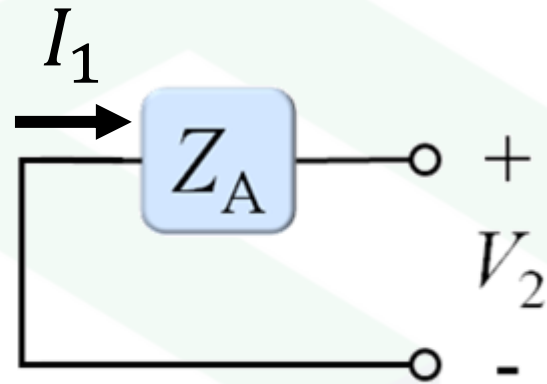
$$Y_{11} = \left. \frac{I_1}{V_1} \right|_{V_2=0}$$


The diagram shows a circuit for calculating the admittance parameter Y_{11} . It consists of a blue rectangular block labeled Z_A representing an impedance. The input terminals on the left are labeled with a plus sign (+) at the top and a minus sign (-) at the bottom. The voltage across these terminals is denoted as V_1 . An arrow labeled I_1 indicates the current entering the top terminal. The circuit is a simple loop where the impedance Z_A is connected between the two terminals.

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

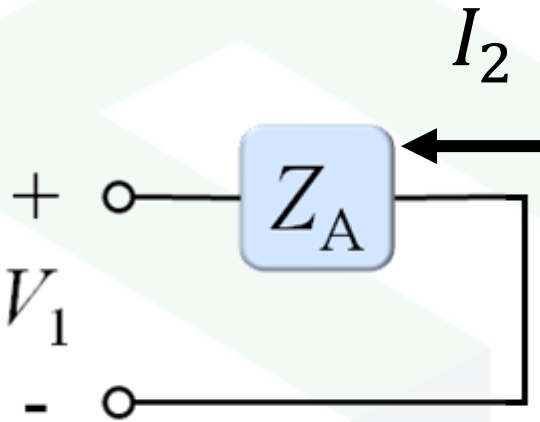
Example #1 – Impedance and Admittance Parameters

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



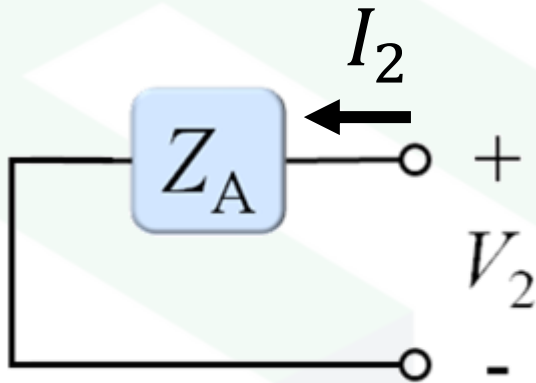
$$Y_{12} = \left. \frac{I_1}{V_2} \right|_{V_1=0} = \frac{-V_2/Z_A}{V_2} = \boxed{\frac{-1}{Z_A}}$$

Example #1 – Impedance and Admittance Parameters

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


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

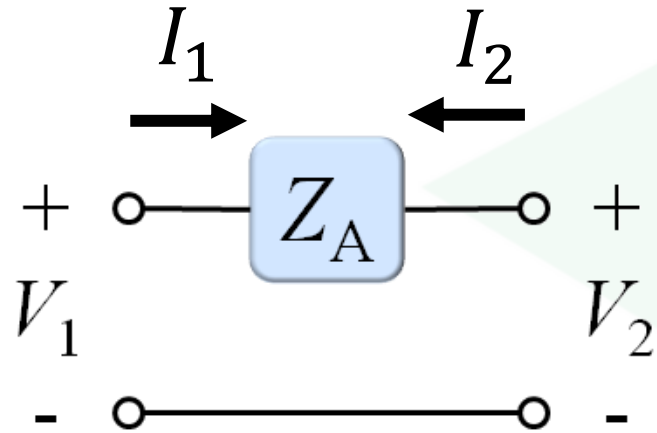
Example #1 – Impedance and Admittance Parameters

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


The diagram shows a circuit with a single loop. A blue rectangular component labeled Z_A is connected in series with a voltage source. The voltage source is represented by two terminals: the top terminal is marked with a '+' sign and the bottom terminal with a '-' sign. The voltage across the source is labeled V_2 . An arrow labeled I_2 indicates current flowing from the right terminal towards the Z_A component.

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

Example #1 – Impedance and Admittance Parameters

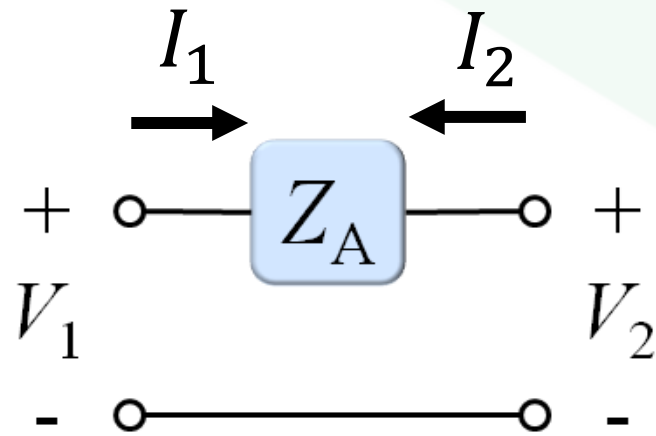


$$Y_{ij} = \left. \frac{I_i}{V_j} \right|_{\text{all other voltages zero}}$$

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

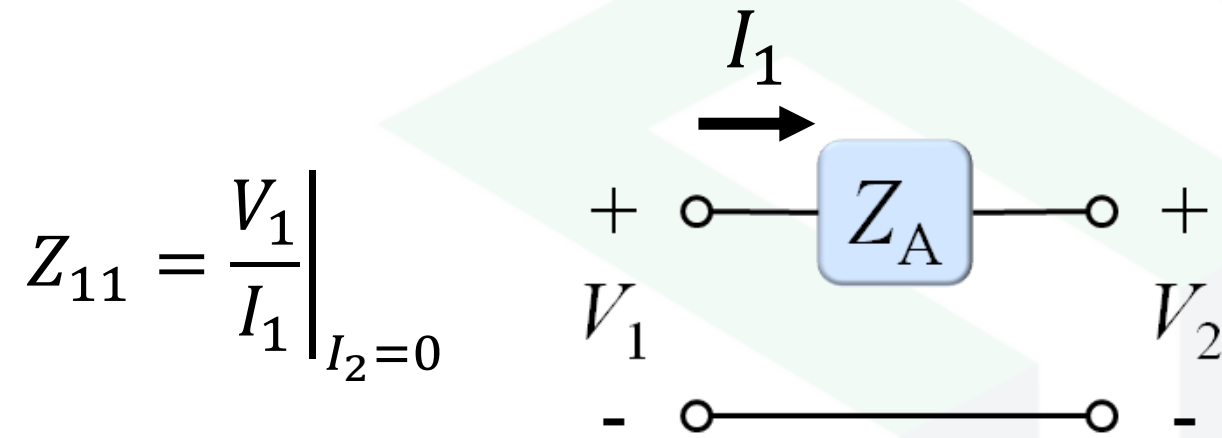
Example #1 – Impedance and Admittance Parameters

Obtain the impedance parameters of the network shown below.



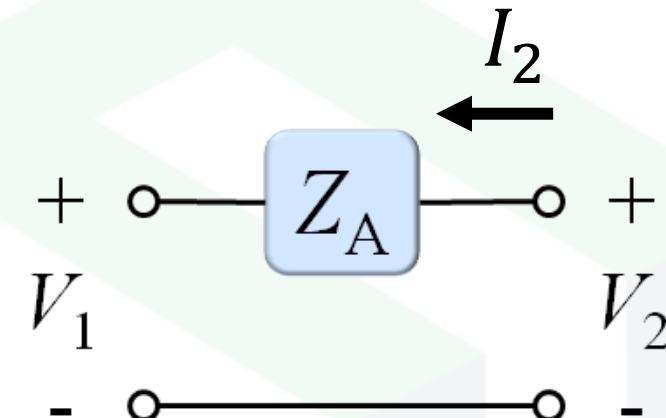
$$Z_{ij} = \left. \frac{V_i}{I_j} \right|_{\text{all other currents zero}}$$

Example #1 – Impedance and Admittance Parameters



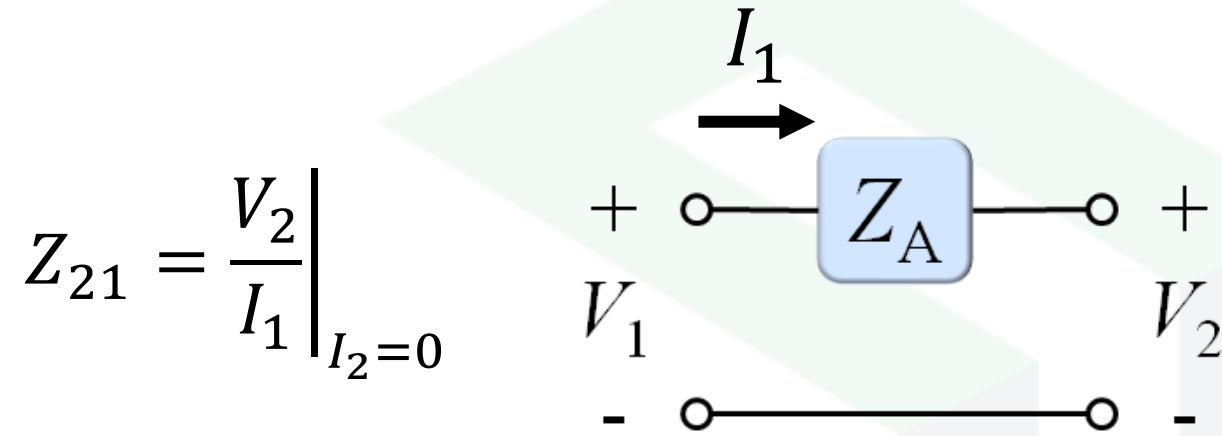
$$Z_{11} = \frac{V_1}{I_1} \Big|_{I_2=0} = \boxed{\infty}$$

Example #1 – Impedance and Admittance Parameters

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


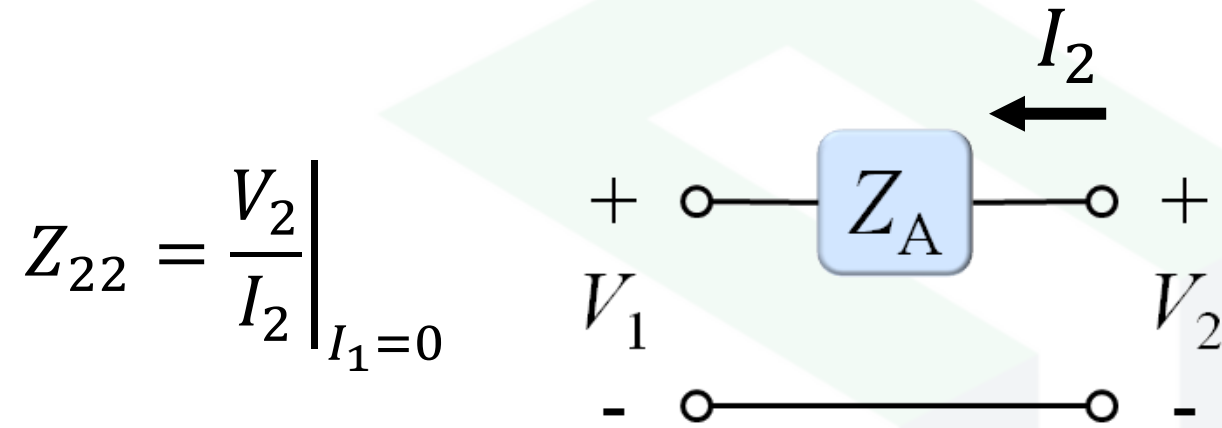
$$Z_{12} = \left. \frac{V_1}{I_2} \right|_{I_1=0} = \boxed{\infty}$$

Example #1 – Impedance and Admittance Parameters



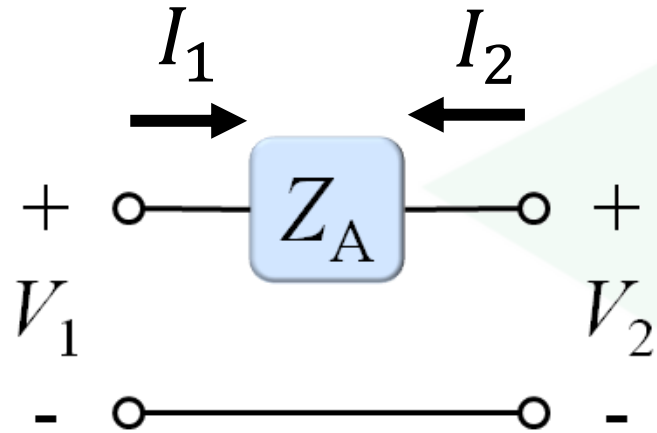
$$Z_{21} = \frac{V_2}{I_1} \Big|_{I_2=0} = \boxed{\infty}$$

Example #1 – Impedance and Admittance Parameters



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

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

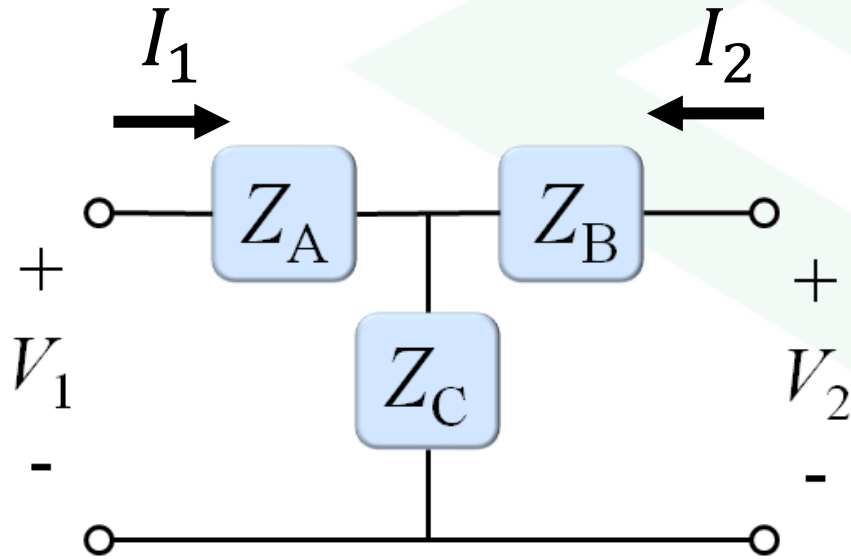
Lossless? if Z_A is purely imaginary

Example #2 – T-Network Impedance Parameters



Example #2 – Impedance Parameters

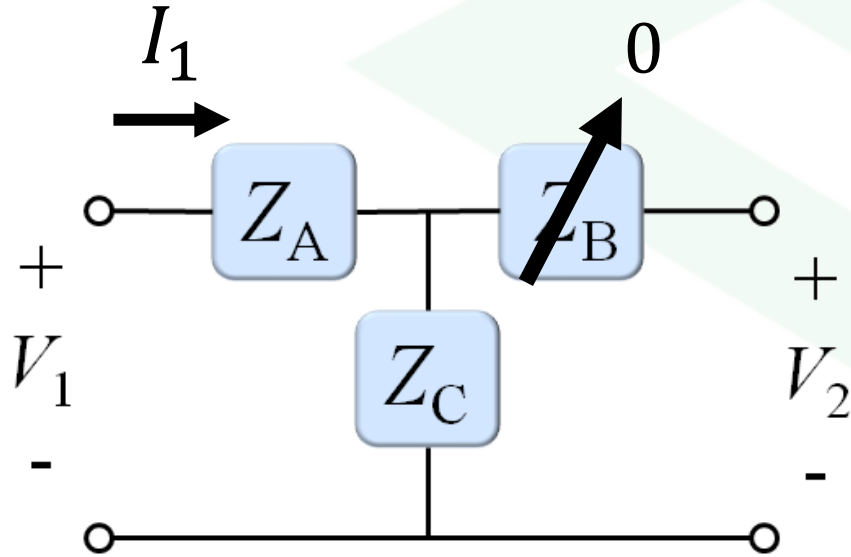
Obtain the impedance parameters of the network shown below.



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

Example #2 – Impedance Parameters

Obtain the impedance parameters of the network shown below.



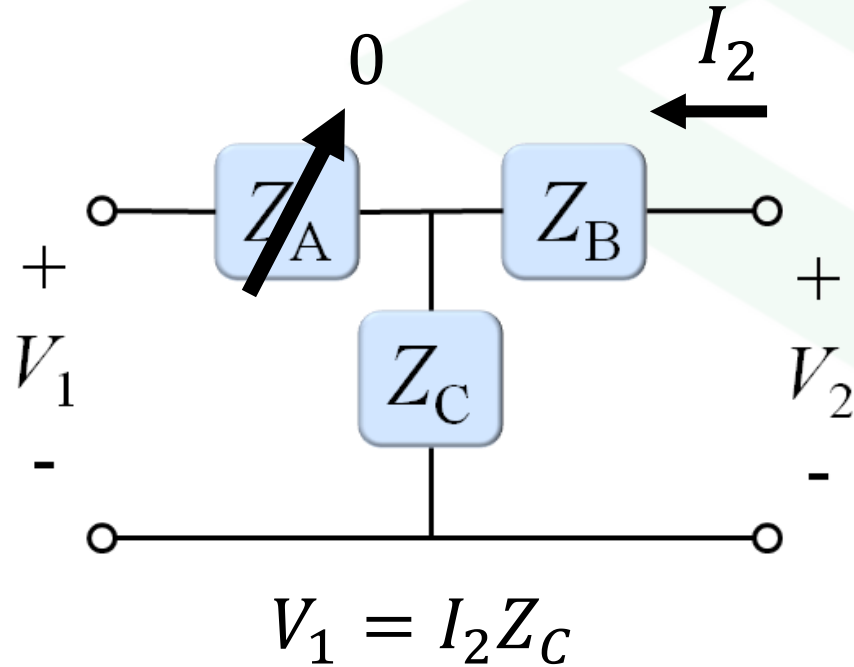
$$I_1 = \frac{V_1}{Z_A + Z_C}$$

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

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

Example #2 – Impedance Parameters

Obtain the impedance parameters of the network shown below.

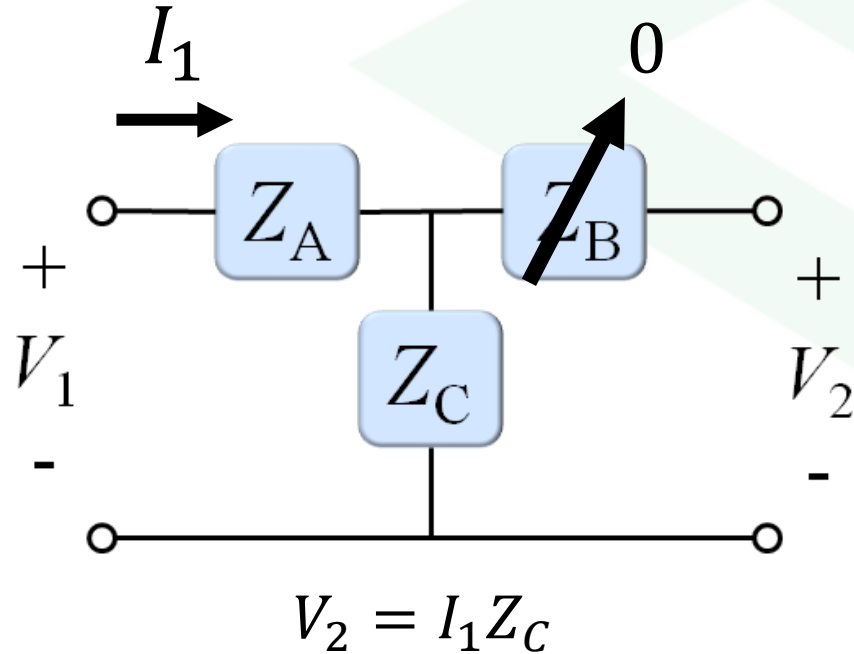


$$Z_{12} = \frac{V_1}{I_2} \Big|_{I_1=0}$$

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

Example #2 – Impedance Parameters

Obtain the impedance parameters of the network shown below.

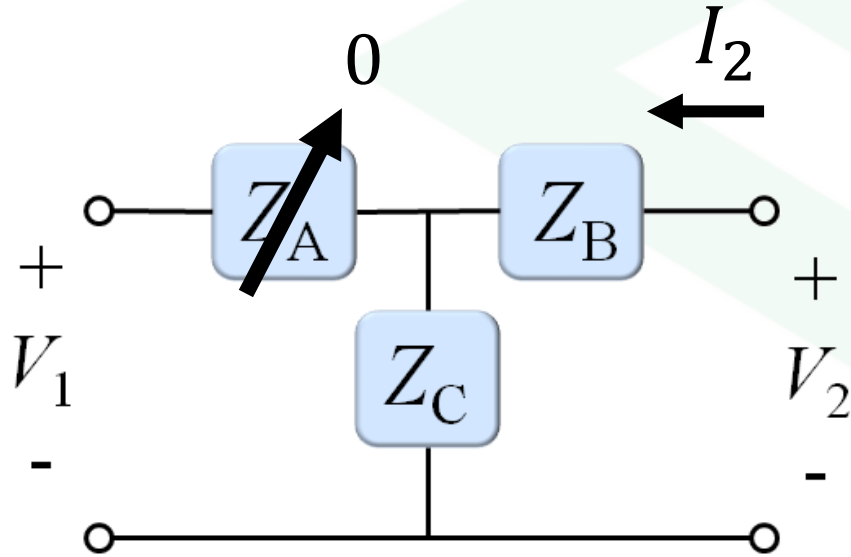


$$Z_{21} = \left. \frac{V_2}{I_1} \right|_{I_2=0}$$

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

Example #2 – Impedance Parameters

Obtain the impedance parameters of the network shown below.

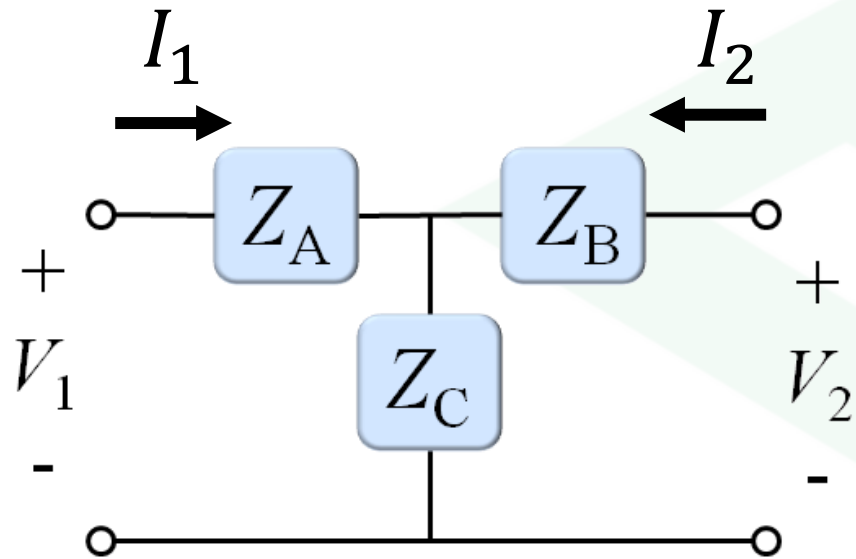


$$I_2 = \frac{V_2}{Z_B + Z_C}$$

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

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

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