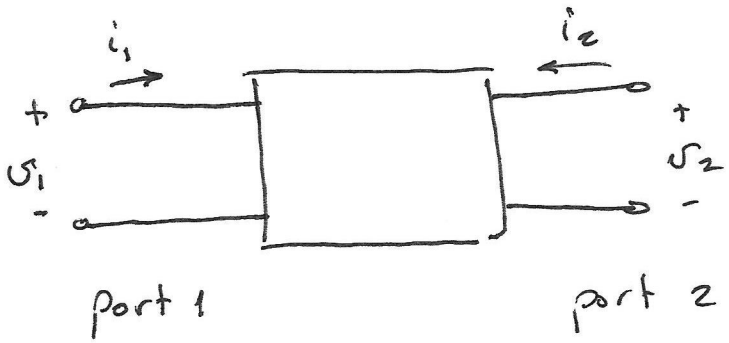
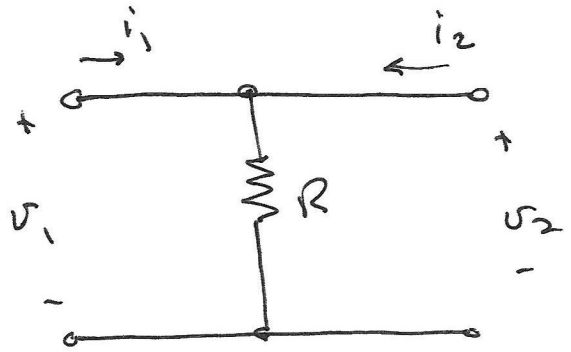
Impedance Parameters



$$v_1 = z_{11} i_1 + z_{12} i_2$$

$$v_2 = z_{21} i_1 + z_{22} i_2$$



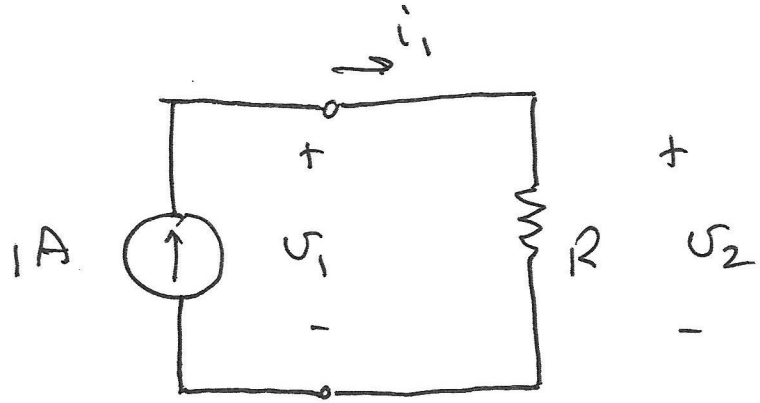
(1) $$z_{11} = \left.\frac{v_1}{i_1}\right|_{i_2 = 0}$$

(2) $$z_{12} = \left.\frac{v_1}{i_2}\right|_{i_1 = 0}$$

(3) $$z_{21} = \left.\frac{v_2}{i_1}\right|_{i_2 = 0}$$

(4) $$z_{22} = \left.\frac{v_2}{i_2}\right|_{i_1 = 0}$$

To determine z_{11} and z_{21}, connect nothing to the r.h.s. (port 2)

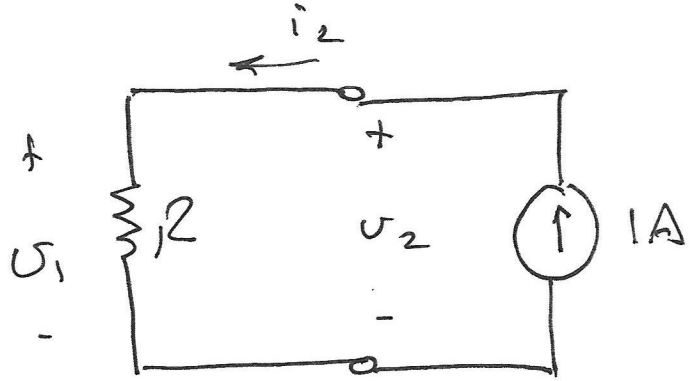


(1) $z_{11} = \left.\frac{v_1}{i_1}\right|_{i_2=0} = \left. v_1 \right|_{i_2=0,\ i_1=1}$

$= R$

(3) $z_{21} = \left.\frac{v_2}{i_1}\right|_{i_2=0} = \left. v_2 \right|_{i_2=0,\ i_1=1}$

$= R$



(2) $z_{12} = \left.\frac{v_1}{i_2}\right|_{i_1=0} = v_1 \Big|_{i_1=0,\ i_2=}$

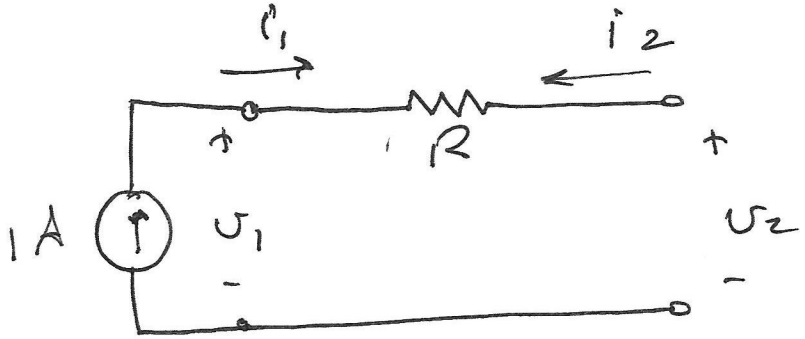
$= R$

(4) $z_{22} = \left.\frac{v_2}{i_2}\right|_{i_1=0} = v_2 \Big|_{i_1=0,\ i_2=}$

$= R$

$\therefore \quad v_1 = R i_1 + R i_2$

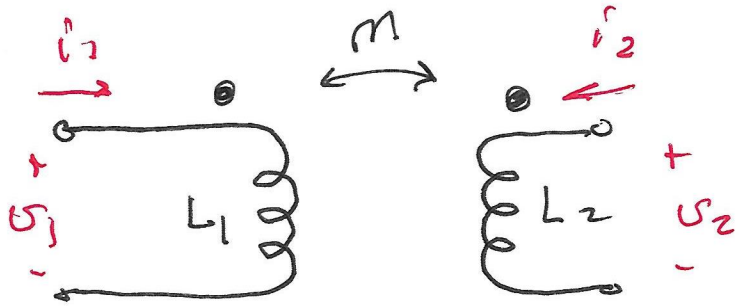
$v_2 = R i_1 + R i_2$



$$z_{11} = \left.\frac{v_1}{i_1}\right|_{i_2=0} = \left. v_1 \right|_{i_2=0,\ i_1=1} = ?$$

impossible

This 2-port network does not have an impedance parameter description.

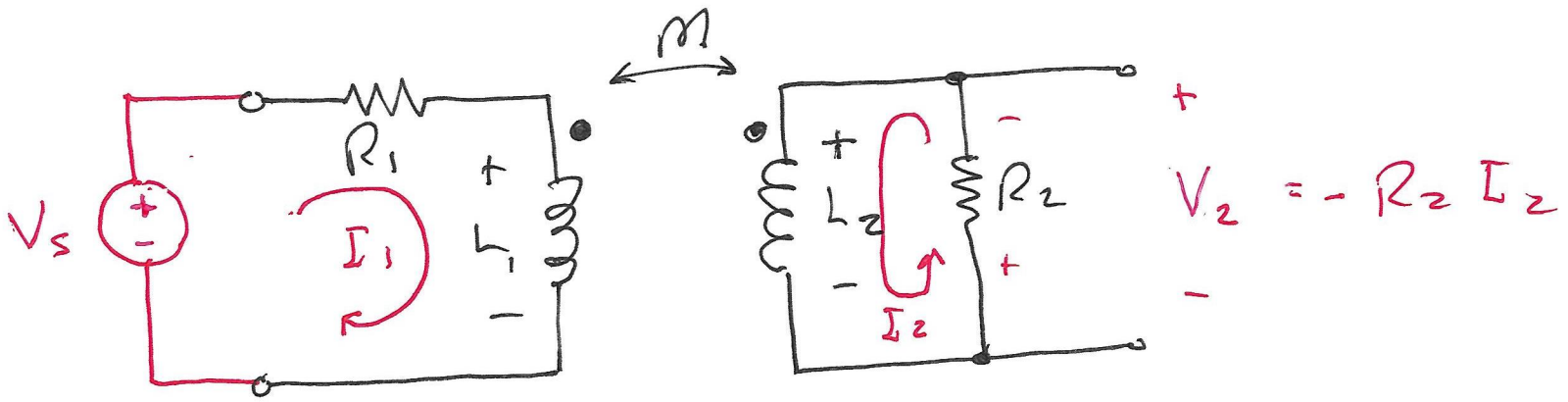


$$v_1 = L_1 \frac{di_1}{dt} + M \frac{di_2}{dt}$$

$$v_2 = M \frac{di_1}{dt} + L_2 \frac{di_2}{dt}$$

$$V_1 = j\omega L_1 I_1 + j\omega M I_2$$

$$V_2 = j\omega M I_1 + j\omega L_2 I_2$$



$$-V_s + R_1 I_1 + j\omega L_1 I_1 + j\omega M I_2 = 0$$

$$R_2 I_2 + j\omega L_2 I_2 + j\omega M I_1 = 0$$

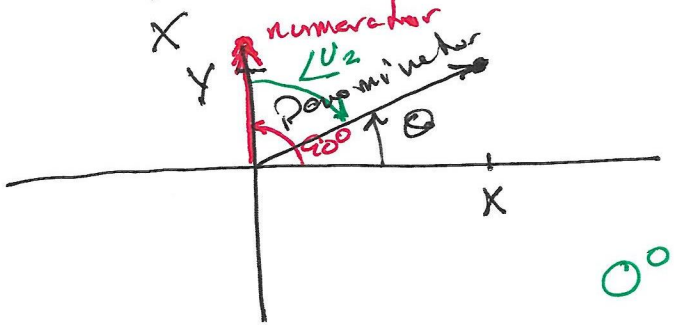
Solve for I_2. Then $V_2 = -R_2 I_2$

$$\begin{bmatrix} R_1 + j\omega L_1 & j\omega M \\ j\omega M & R_2 + j\omega L_2 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_s \\ 0 \end{bmatrix}$$

Use Cramer's Rule:

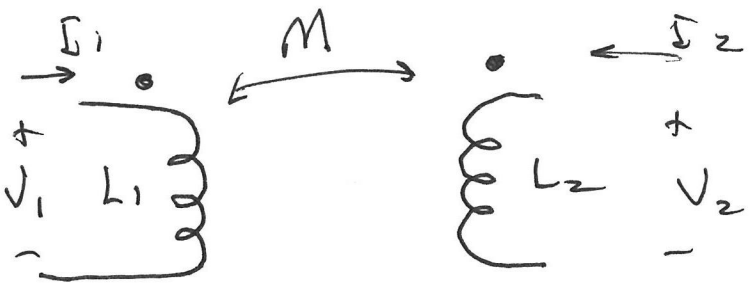
$$I_2 = \frac{\begin{vmatrix} R_1 + j\omega L_1 & V_s \\ j\omega M & 0 \end{vmatrix}}{\begin{vmatrix} R_1 + j\omega L_1 & j\omega M \\ j\omega M & R_2 + j\omega L_2 \end{vmatrix}} = \frac{0 - j\omega M V_s}{(R_1 + j\omega L_1)(R_2 + j\omega L_2) + \omega^2 M^2}$$

$$V_2 = \frac{j\omega M V_s R_2}{(R_1 R_2 + \omega^2 L_1 L_2 + \omega^2 M^2) + j\omega (L_1 R_2 + L_2 R_1)}$$



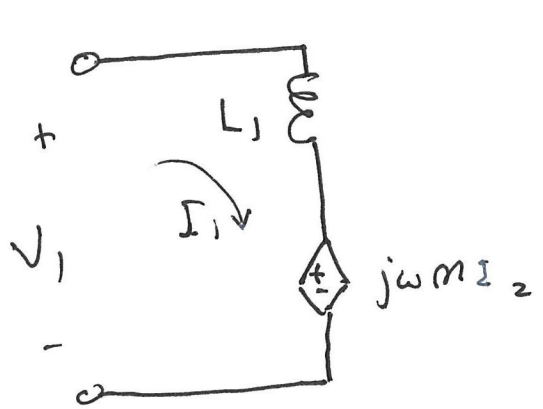
$0 \leq \theta \leq 90°$

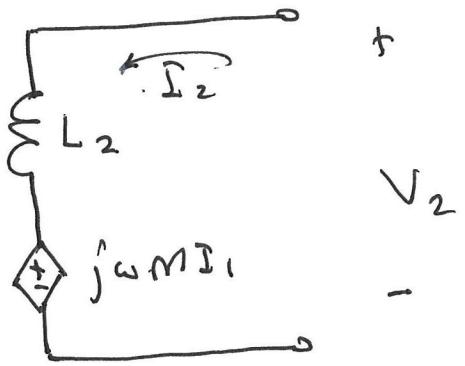
$0° \leq V_2$ angle $\leq 90°$

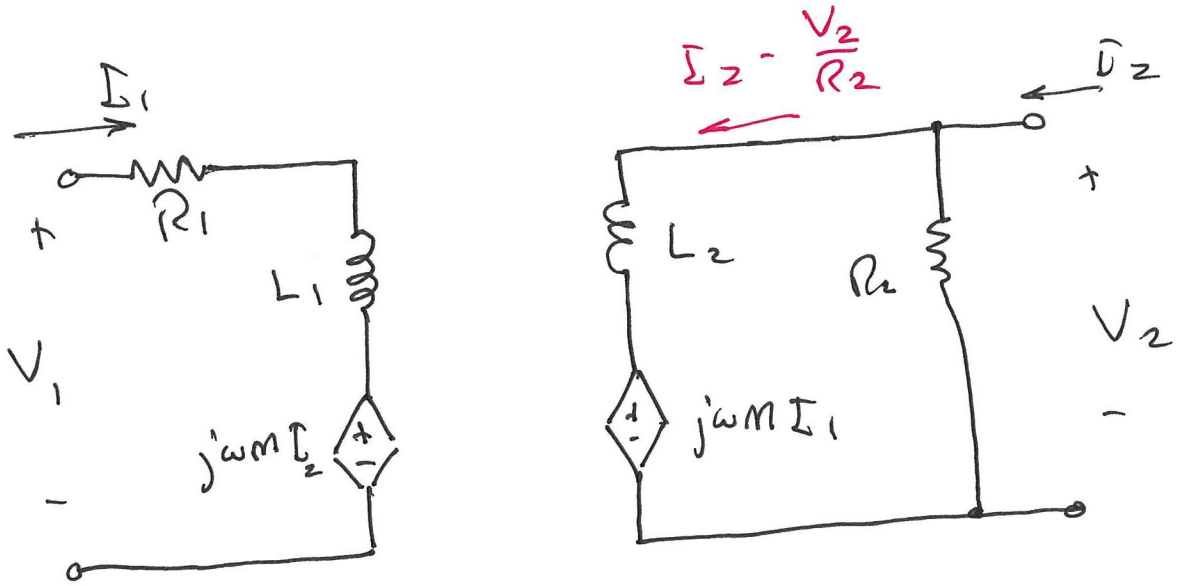


$$V_1 = j\omega L_1 I_1 + j\omega M I_2$$

$$V_2 = j\omega M I_1 + j\omega L_2 I_2$$






$\bar{I}_1$
R_1
L_1
V_1
$j\omega M \bar{I}_2$
$\bar{I}_2 = \frac{V_2}{R_2}$
$\bar{I}_2$
L_2
R_2
V_2
$j\omega M \bar{I}_1$