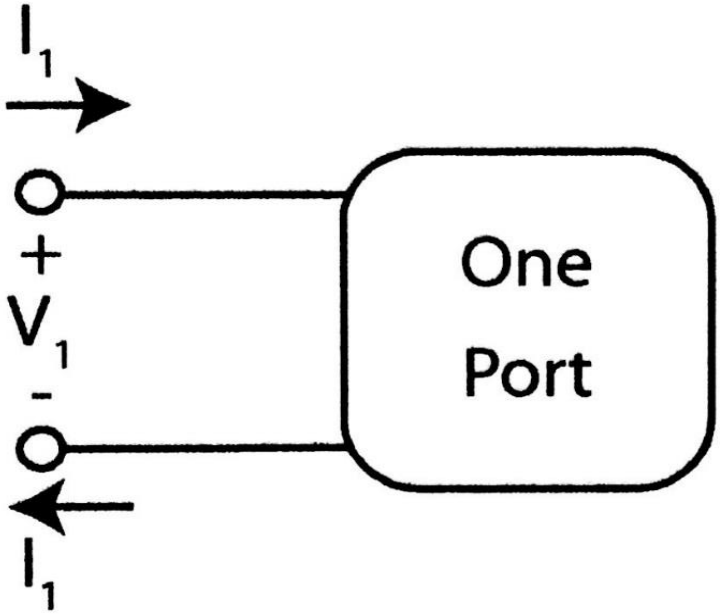
Two Port Network
Linear Circuit Analysis II
EECE 202

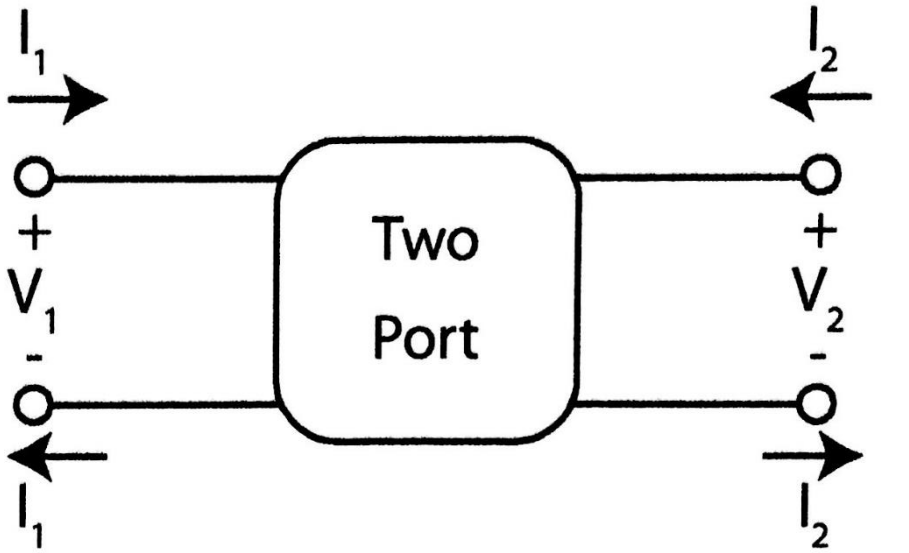
Lecture Objectives

Two port networks.

(Y) and (Z) parameters.

One port and two port networks

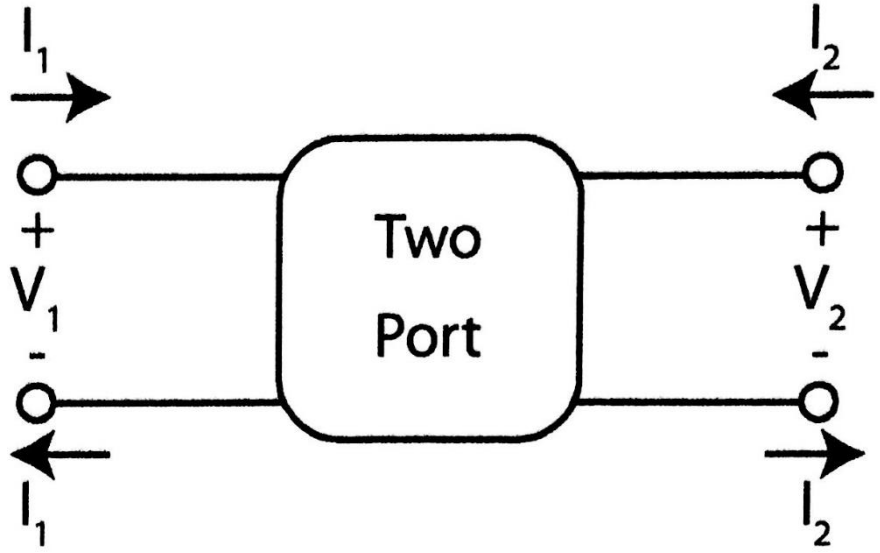




$$Z_{in} = \frac{V_1}{I_1}$$

Z parameters

Two port networks



Z parameters

H parameters

Y parameters

T parameters

Two Port Networks

Y parameters

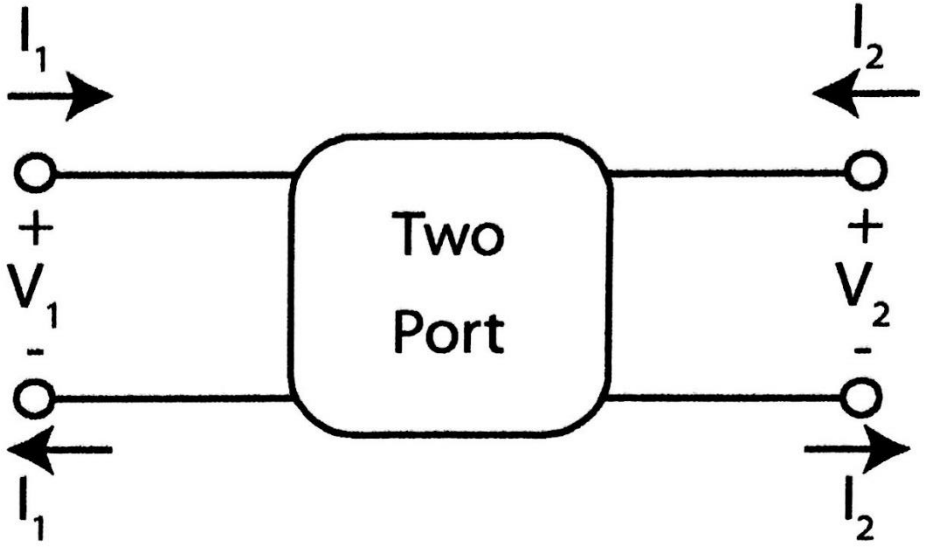
$$I_1 = y_{11}V_1 + y_{12}V_2$$

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

Z parameters

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

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



Two port networks

Z parameters

Z parameters of the two Port network.

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} * \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

Y parameters

Y parameters of the two Port network.

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} * \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

Two Port Networks

Z parameters

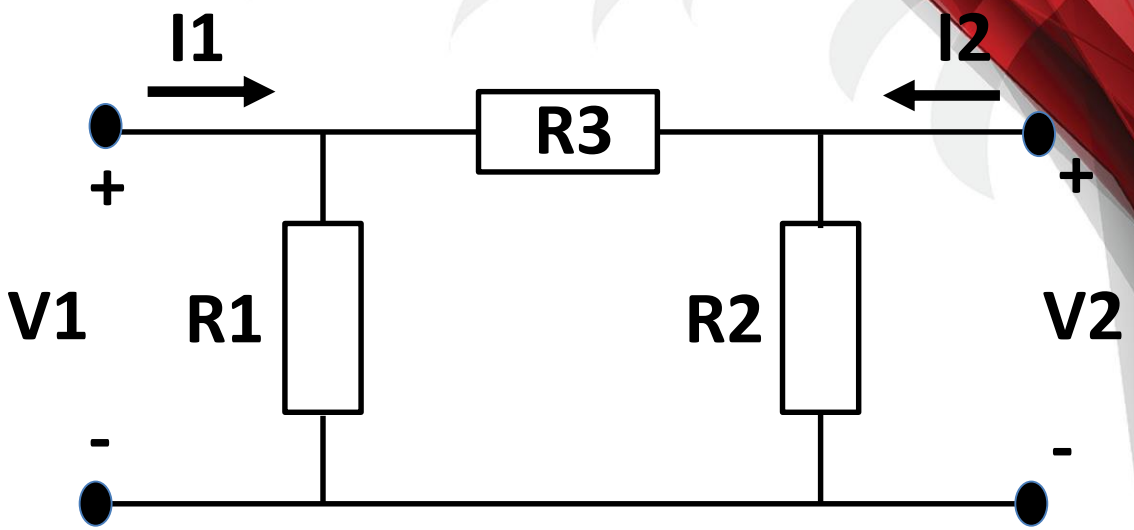
Use mesh analysis

Y parameters

Use Nodal analysis

Two port network

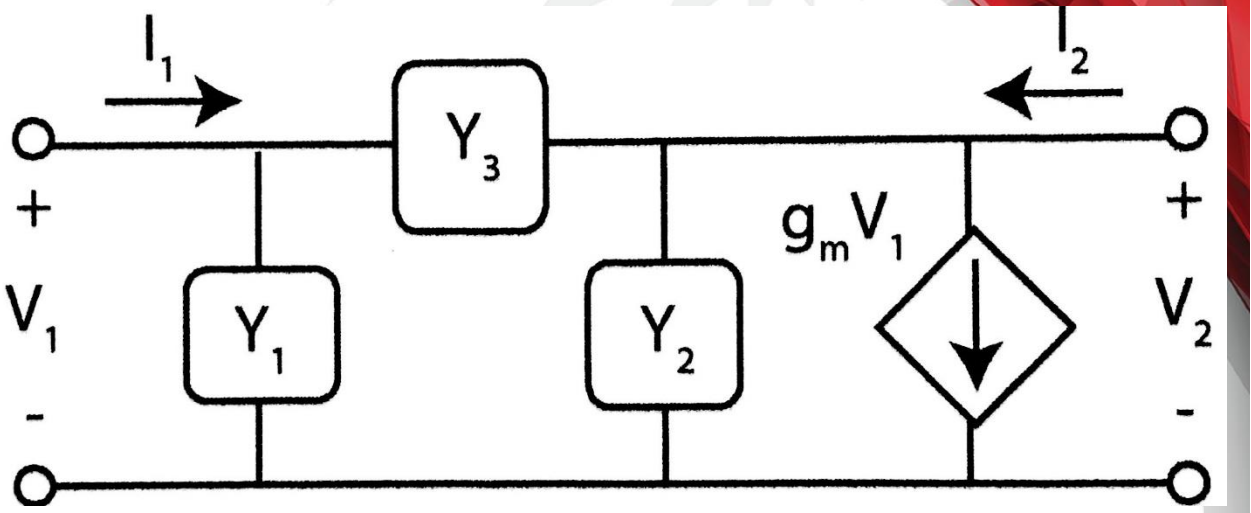
Compute the admittance (Y) parameters of the circuit shown



$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} \left(\frac{1}{R_1} + \frac{1}{R_3}\right) & -\frac{1}{R_3} \\ -\frac{1}{R_3} & \left(\frac{1}{R_2} + \frac{1}{R_3}\right) \end{bmatrix} * \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

Two port network

Compute the admittance (Y) parameters of the circuit shown



$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_1 + Y_3 & -Y_3 \\ g_m - Y_3 & Y_2 + Y_3 \end{bmatrix} * \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

Two port networks

Z parameters

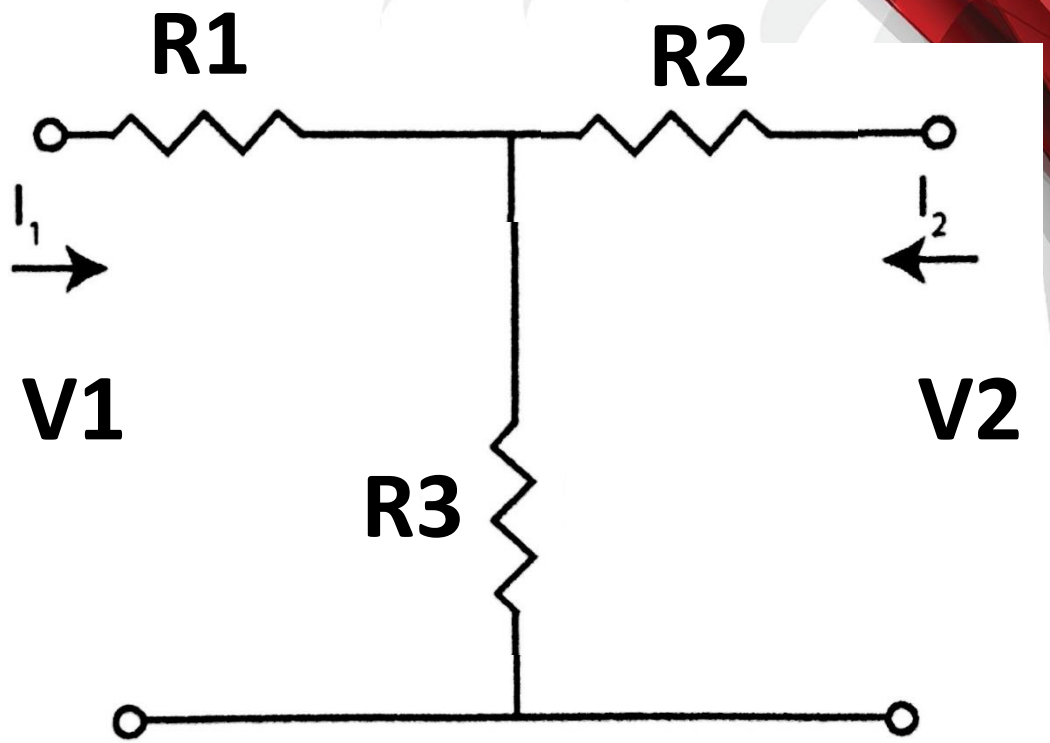
$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} * \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

Z parameters of the two Port network.

Two port network

Compute the impedance (Z) parameters of the circuit shown

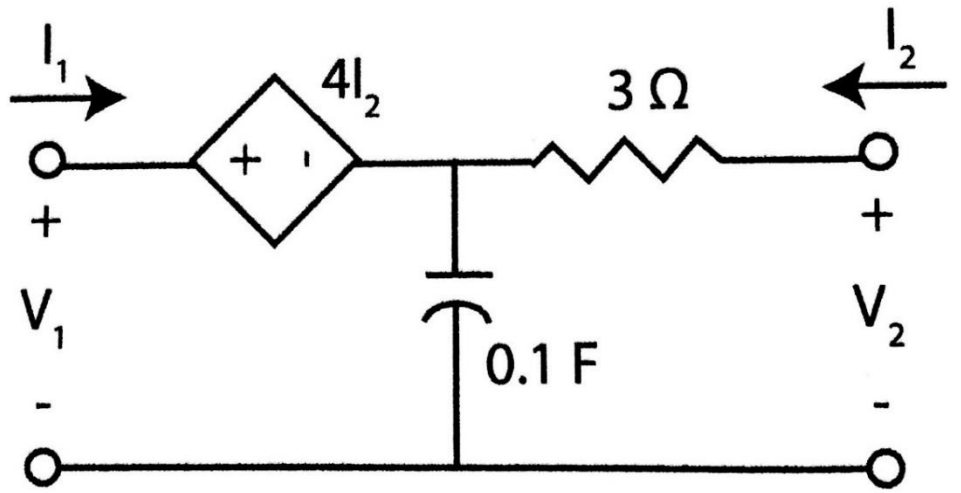
$$Z = \begin{bmatrix} (R1 + R3) & R3 \\ R3 & (R2 + R3) \end{bmatrix}$$



Two port network

Compute the impedance (Z) parameters of the circuit shown

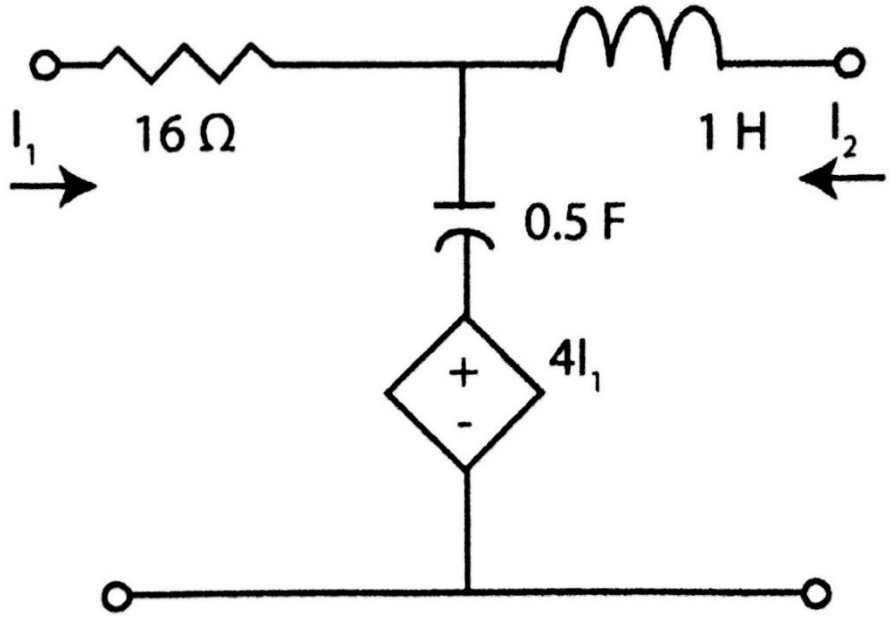
$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} \frac{10}{s} & \frac{4s+10}{s} \\ \frac{10}{s} & \frac{3s+10}{s} \end{bmatrix} * \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$



Two port network

Compute the impedance (Z) parameters of the circuit shown

$$Z = \begin{bmatrix} 20 + \frac{1}{0.5s} & \frac{1}{0.5s} \\ 4 + \frac{1}{0.5s} & s + \frac{1}{0.5s} \end{bmatrix}$$



Hybrid parameters

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

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

Transmission parameters

$$V_1 = t_{11}V_2 + t_{12}I_2$$

$$I_1 = t_{21}V_2 - t_{22}I_2$$

	z-Parameters	y-Parameters	h-Parameters	t-Parameters
z-Parameters	$\begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix}$	$\begin{bmatrix} \frac{y_{22}}{\Delta y} & \frac{-y_{12}}{\Delta y} \\ \frac{-y_{21}}{\Delta y} & \frac{y_{11}}{\Delta y} \end{bmatrix}$	$\begin{bmatrix} \frac{\Delta h}{h_{22}} & \frac{h_{12}}{h_{22}} \\ -\frac{h_{21}}{h_{22}} & \frac{1}{h_{22}} \end{bmatrix}$	$\begin{bmatrix} \frac{t_{11}}{t_{21}} & \frac{\Delta t}{t_{21}} \\ \frac{1}{t_{21}} & \frac{t_{22}}{t_{21}} \end{bmatrix}$
y-Parameter	$\begin{bmatrix} \frac{z_{22}}{\Delta z} & \frac{-z_{12}}{\Delta z} \\ \frac{-z_{21}}{\Delta z} & \frac{z_{11}}{\Delta z} \end{bmatrix}$	$\begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix}$	$\begin{bmatrix} \frac{1}{h_{11}} & \frac{-h_{12}}{h_{11}} \\ \frac{h_{21}}{h_{11}} & \frac{\Delta h}{h_{11}} \end{bmatrix}$	$\begin{bmatrix} \frac{t_{22}}{t_{12}} & \frac{-\Delta t}{t_{12}} \\ \frac{-1}{t_{12}} & \frac{t_{11}}{t_{12}} \end{bmatrix}$
h-Parameter	$\begin{bmatrix} \frac{\Delta z}{z_{22}} & \frac{z_{12}}{z_{22}} \\ -\frac{z_{21}}{z_{22}} & \frac{1}{z_{22}} \end{bmatrix}$	$\begin{bmatrix} \frac{1}{y_{11}} & \frac{-y_{12}}{y_{11}} \\ \frac{y_{21}}{y_{11}} & \frac{\Delta y}{y_{11}} \end{bmatrix}$	$\begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix}$	$\begin{bmatrix} \frac{t_{12}}{t_{22}} & \frac{\Delta t}{t_{22}} \\ \frac{-1}{t_{22}} & \frac{t_{21}}{t_{22}} \end{bmatrix}$
t-Parameter	$\begin{bmatrix} \frac{z_{11}}{z_{21}} & \frac{\Delta z}{z_{21}} \\ \frac{1}{z_{21}} & \frac{z_{22}}{z_{21}} \end{bmatrix}$	$\begin{bmatrix} \frac{-y_{22}}{y_{21}} & \frac{-1}{y_{21}} \\ \frac{-\Delta y}{y_{21}} & \frac{-y_{11}}{y_{21}} \end{bmatrix}$	$\begin{bmatrix} \frac{-\Delta h}{h_{21}} & \frac{-h_{11}}{h_{21}} \\ \frac{-h_{22}}{h_{21}} & \frac{-1}{h_{21}} \end{bmatrix}$	$\begin{bmatrix} t_{11} & t_{12} \\ t_{21} & t_{22} \end{bmatrix}$