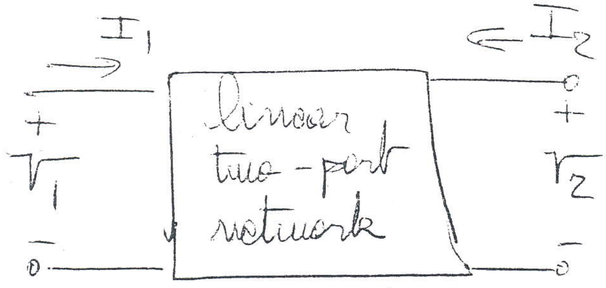
Appendix B

Two-Port Network Parameters



Generic 2-port network with 4 port variables ($I_{1,2}$; $V_{1,2}$)

If V_1, V_2 are independent variables

$$I_1 = y_{11} V_1 + y_{12} V_2$$
$$I_2 = y_{21} V_1 + y_{22} V_2$$

→ units: Siemens

The four parameters $y_{11}, y_{12}, y_{21}, y_{22}$ have dimension of admittances. They completely characterize the 2-port network. We can also rewrite the 2 relations above in a matrix form

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

How do we determine y_{ij} $(i, j = 1, 2)$

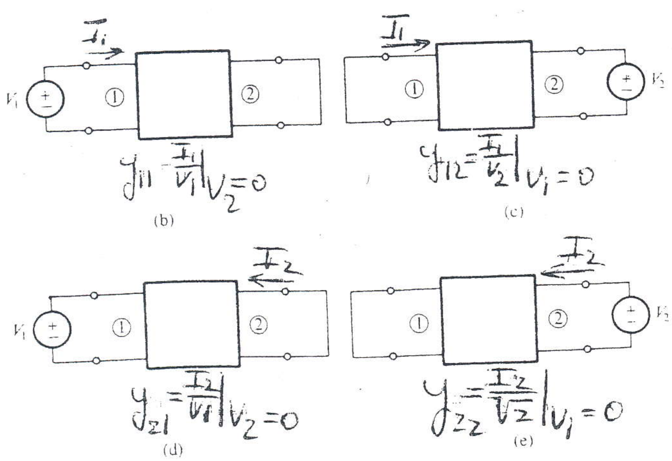
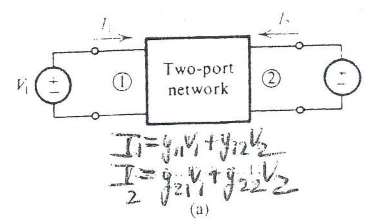


Fig. B.2 Definition and conceptual measurement circuits for y parameters.

Matrix representation

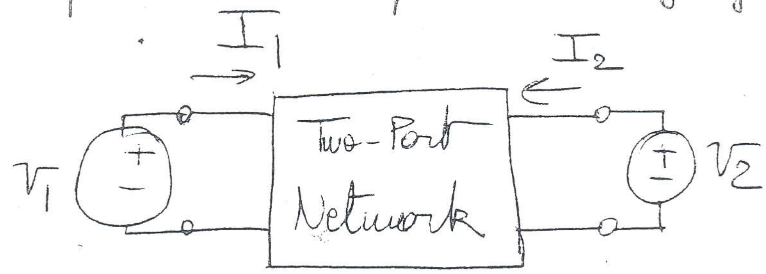


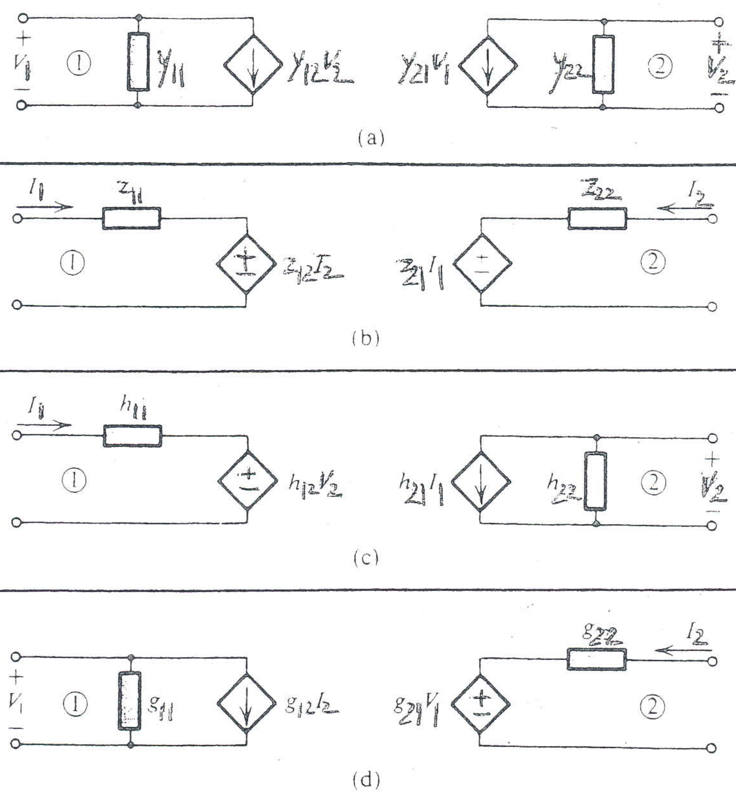
IN ↓

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

↑ OUT

Equivalent Two-port Network for feedback circuits





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

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

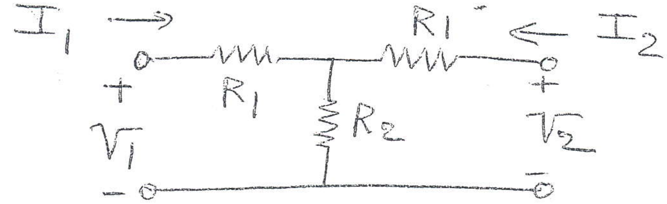
$$\begin{bmatrix} V_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ V_2 \end{bmatrix}$$

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

FIGURE B.6 Equivalent circuits for two-port networks in terms of (a) y, (b) z, (c) h, and (d) g parameters.

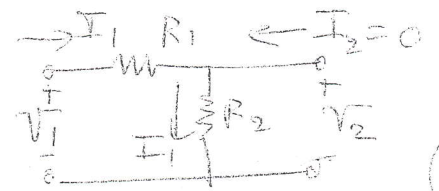
III.(20pts): **Two port feedback network**

Consider the feedback network below and calculate its **FOUR** z-parameters. Draw explicitly each of the small circuit diagram needed to calculate each of the four z-parameters. Also, calculate the explicit values of the four parameters z_{11}, z_{12}, z_{21}, and z_{22} and give their **UNITS** if $R_1 = 1M\Omega$ and $R_2 = 100k\Omega$.



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

$$z_{11} = \frac{V_1}{I_1}\bigg|_{I_2=0}$$

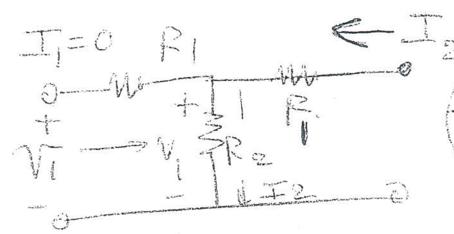


+5.0

$$V_1 = (R_1+R_2)I_1$$

$$\rightarrow z_{11} = R_1 + R_2 = 1.1\,M\Omega$$

$$z_{12} = \frac{V_1}{I_2}\bigg|_{I_1=0}$$



+5.0

$$V_1 = R_2 I_2 \rightarrow z_{12} = R_2 = 100\,k\Omega$$

$$z_{22} = \frac{V_2}{I_2}\bigg|_{I_1=0} = z_{11} \text{ by symmetry} = 1.1\,M\Omega$$ +5.0

$$z_{21} = \frac{V_2}{I_1}\bigg|_{I_2=0} = z_{12} = \text{By by symmetry} = R_2 = 100\,k\Omega$$

+5.0