**16.202: Two Port Networks**

- **Port**: A pair of terminals where current entering one terminal leaves through the other.

- Relate voltages and currents at the terminals using:
  - Impedance Parameters
  - Admittance Parameters
  - Hybrid Parameters

![Diagram of a two port network](image)

**Figure 1:**

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16.202: Circuit Theory II; ECE, UMASS Lowell
Impedance Parameters: \( \{ z \} \)

\[
V_1 = z_{11} I_1 + z_{12} I_2 \\
V_2 = z_{21} I_1 + z_{22} I_2
\]

\[
z_{21} = \left. \frac{V_2}{I_1} \right|_{I_2=0} \quad z_{11} = \left. \frac{V_1}{I_1} \right|_{I_2=0} \quad \text{Output Open Circuit}
\]

\[
z_{12} = \left. \frac{V_1}{I_2} \right|_{I_1=0} \quad z_{22} = \left. \frac{V_2}{I_2} \right|_{I_1=0} \quad \text{Input Open Circuit}
\]

- \( z_{11}, z_{22} \): Driving point impedances or OC input/output impedances
- \( z_{12}, z_{21} \): Transfer Impedances

Figure 2:
Admittance Parameters \( \{y\} \)

\[
I_1 = y_{11} V_1 + y_{12} V_2 \\
I_2 = y_{21} V_1 + y_{22} V_2
\]

- \( y_{21} = \frac{I_2}{V_1} \big|_{V_2=0} \); \( y_{11} = \frac{I_1}{V_1} \big|_{V_2=0} \): Output Short Circuit
- \( y_{12} = \frac{I_1}{V_2} \big|_{V_1=0} \); \( y_{22} = \frac{I_2}{V_2} \big|_{V_1=0} \): Input Short Circuit
- \( y_{11}, y_{22} \): Short circuit input/output admittance parameters
- \( y_{12}, y_{21} \): Short circuit transfer admittance parameters
Hybrid Parameters \( \{ h \} \)

\[
\begin{align*}
V_1 &= h_{11}I_1 + h_{12}V_2 \\
I_2 &= h_{21}I_1 + h_{22}V_2
\end{align*}
\]

- \( h_{11} = \frac{V_1}{I_1} \bigg|_{V_2=0} \) : Short-Circuit Input Impedance
- \( h_{21} = \frac{I_2}{I_1} \bigg|_{V_2=0} \) : Short-Circuit Forward Current Gain
- \( h_{12} = \frac{V_1}{V_2} \bigg|_{I_1=0} \) : Open-Circuit Reverse Voltage Gain
- \( h_{22} = \frac{I_2}{V_2} \bigg|_{I_1=0} \) : Open-Circuit Output Impedance