Two-Port Network Parameters

- Used to characterize a linear two-port network.
- For variables of interest

\[ I_1 \rightarrow I_2 \]
\[ V_1 \rightarrow V_2 \]

- For different types of network parameters, depending on which variables are being "excited" and which are being observed.

**Y-parameters:** Assume \( V_1, V_2 \) are being set and \( I_1, I_2 \) are being observed.

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

To find parameters:

- Short \( V_2 \), apply \( V_1 \) and measure \( I_1 \).

Similarly, for \( y_{12} = \frac{I_1}{V_2} \) when \( V_1 = 0 \).

- Short \( V_1 \), apply \( V_2 \) and measure \( I_2 \).

Same idea for \( y_{21}, y_{22} \).

**Internal representation:**

**Z-parameters:** Assume \( I_1, I_2 \) being set and \( V_1, V_2 \) being observed.

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

Others are a mix of currents & voltages:

**H-parameters** (we used these to model \( B \))

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

**G-parameters**

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

- If you know one set you can convert to any other.
- Choose whichever is computationally most convenient.
Feedback Topologies

1. Voltage Amplifiers - Voltage input, voltage output
   - Series-shunt feedback
     - Example output voltage in shunt (parallel) configuration
   - Sample output voltage in shunt (parallel) configuration

Example: Non-inverting Op-amp circuit:

- Recall that a voltage amplifier (block A above) can be modeled as a VCVS with some input & output resistances.

Applying feedback has effects on three properties of the amplifier:
1. Input resistance (increases)
2. Output resistance (decreases)
3. Gain (reduces & stabilizes w.r.t. DA).

Let's examine these effects, model block as follows:

Here we assume that $\beta$ is unilateral (gain in one direction only) and does not load the output.