Input Resistance $R_{in}$

Looks like a Thevenin resistance measurement, but note that the output port has the load resistance attached.

$R_{in} = \frac{v_t}{i_t}$, $R_{L}$ removed, $R_{S}$ attached

Output Resistance $R_{out}$

Looks like a Thevenin resistance measurement, but note that the input port has the source resistance attached.

$R_{out} = \frac{v_t}{i_t}$, $R_{L}$ removed, $R_{S}$ attached
Lecture 25

- Last time:
  - Two-port small-signal models of amplifiers

- Today:
  - Finish methods for finding two-port model parameters
  - Start common-source amplifier

Finding the Voltage Gain $A_v$

Key idea: the output port is open-circuited and the source resistance is shorted
Finding the Current Gain $A_i$

Key idea: the output port is shorted and the source resistance is removed

$$A_i = \frac{i_{\text{out}}}{i_{\text{in}}} \mid R_s \to \infty, R_L = 0$$

Finding the Transresistance $R_m$

$$R_m = \frac{v_{\text{out}}}{i_{\text{in}}} \mid R_s \to \infty, R_L \to \infty$$
Finding the Transconductance $G_m$

$$G_m = \frac{i_{out}}{V_{in}}$$

Two-Port Amplifier

First Example: the Common-Source Amplifier (again)

What about the load resistor?
DC Bias

Load line analysis:

Load-Line Analysis to find
DC Transfer Function

Small-Signal Analysis

\[ P_{in} = 0 \]

\[ A_v = -g_{m}R_{d} \quad \left( P_{out} = \frac{P_{in}}{A_v} \right) \]
Two-Port Parameters:

Find $R_{in}$, $R_{out}$, $G_m$

\[ G_m = \frac{i_{out}}{v_{in}} = g_m \]

$P_{in} = \infty$

\[ P_{out} = P_{D} / \eta_o \]

\[ i_{out} = g_m v_{in} \]

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Lecture 26

- Last time:
  - Finish methods for finding two-port model parameters
  - Start common-source amplifier

- Today:
  - Current-source supplies
  - Common-gate amplifier
Two-Port CS Model

Reattach source and load one-ports:

\[ A_v = -g_m (\frac{R_o}{R_D}) \]

\[ A_i = \frac{1}{g_m} \left( \frac{R_o}{r_i R_D} \right) \]

\[ g_m = g_m \]

\[ P_{out} = \frac{R_o}{R_D} \]

\[ P_{in} = \infty \]

CE amplifier:

\[ g_m = g_m \]

\[ P_{in} = R_i \| R_o \| r_i \]

\[ P_{out} = \frac{R_o}{R_D} \]