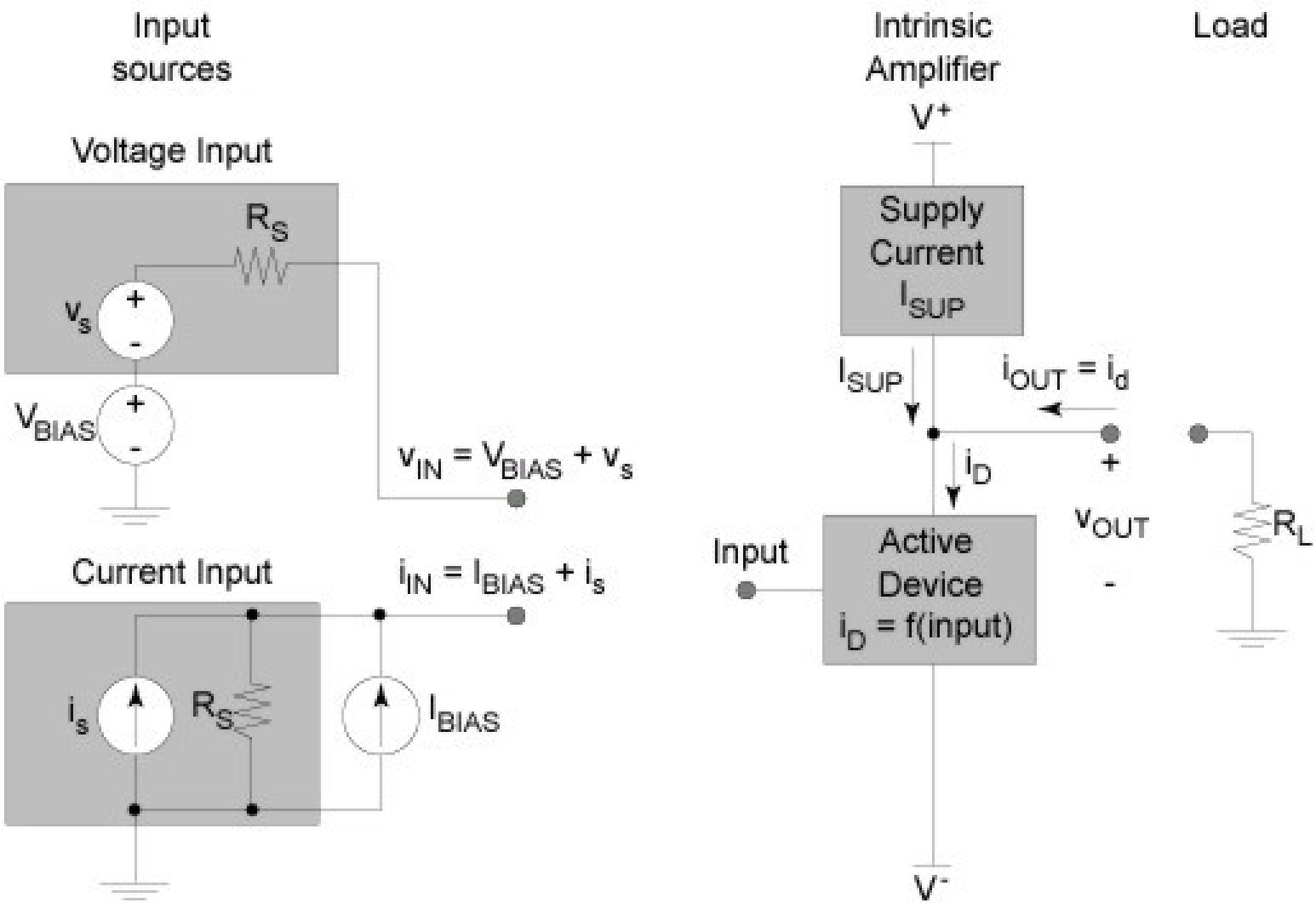
Lecture 24

- Last time:
  - Small-signal model for the entire common-source amplifier
  - Limits to model
- Today :
  - Two-port small-signal models of amplifiers

Generalized Amplifier



Amplifier Terminology

Sources: signal, its source resistance, and bias voltage or current

Load: use resistor in Chap. 8, but could be a general impedance

Port: a pair of terminals across which a voltage and an associated current are defined

source, load: "one port"
amplifier: "two port"

Amplifier Biasing

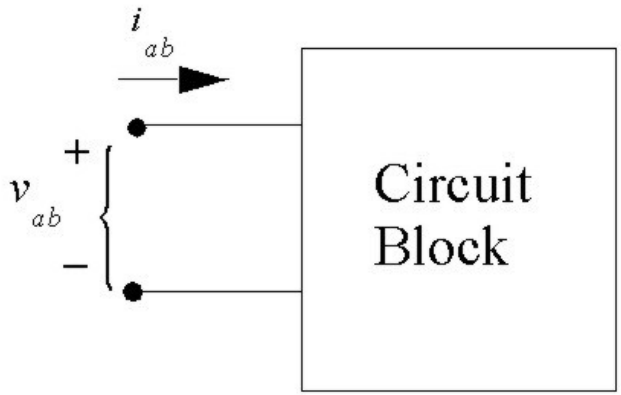
Select V_{IN}(or I_{IN}) to set the DC device current to equal the supply current I_{SUP}.

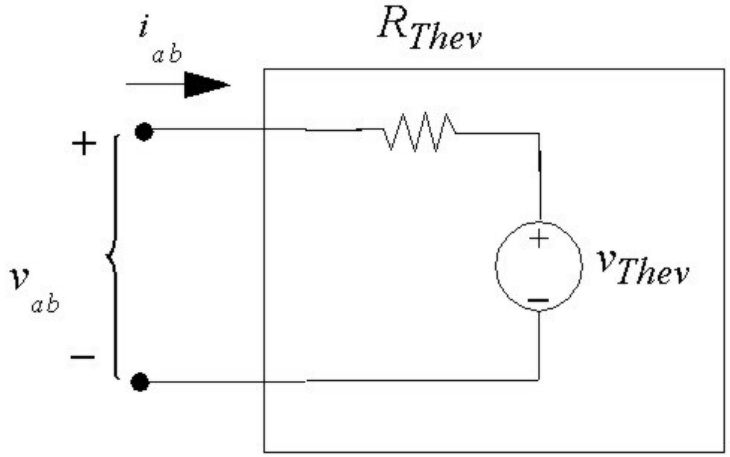
DC output current I_{OUT}=
DC output voltage V_{OUT}=

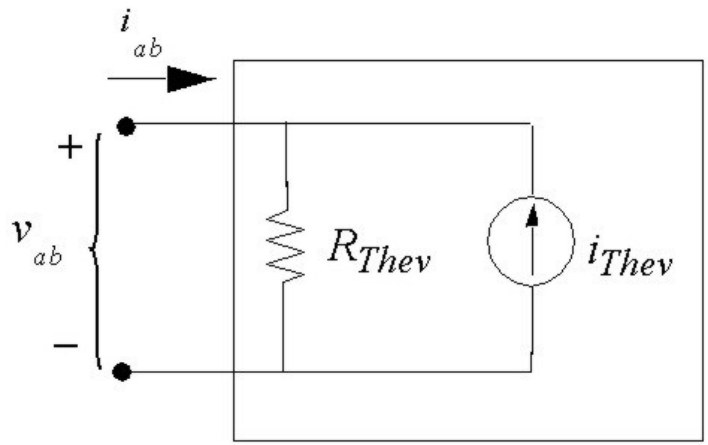
Small-signal source voltage or source current results in small-signal device current i_d →

One-Port Models (EECS 40)

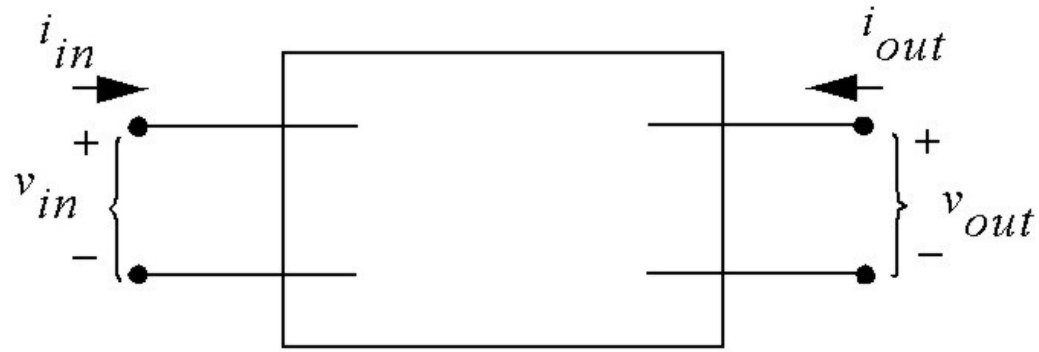
a terminal pair across which a voltage and associated current are defined







Small-Signal Two-Port Models



We assume that input port is linear and that the amplifier is *unilateral*:

The output port : depends linearly on the current and voltage at the input and output ports

Math 54 Perspective

Can write linear system of equations for either i_{out} or v_{out} in terms of two of i_{in}, v_{in}, i_{out}, or v_{out}: possibilities are

$$i_{out} = \alpha_1 v_{in} + \alpha_2 v_{out}$$

$$i_{out} = \alpha_3 i_{in} + \alpha_4 v_{out}$$

$$v_{out} = \alpha_5 v_{in} + \alpha_6 i_{out}$$

$$v_{out} = \alpha_7 i_{in} + \alpha_8 i_{out}$$

What is physical meaning of α_1? of α_6?

EE Perspective

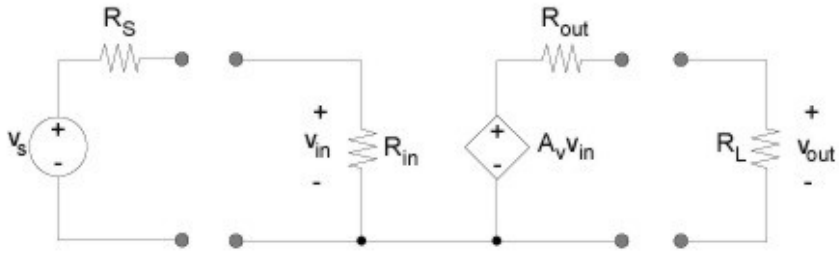
Four amplifier types: determined by the output signal and the input signal … both of which we select (usually obvious)

Voltage
Current
Transconductance
Transresistance

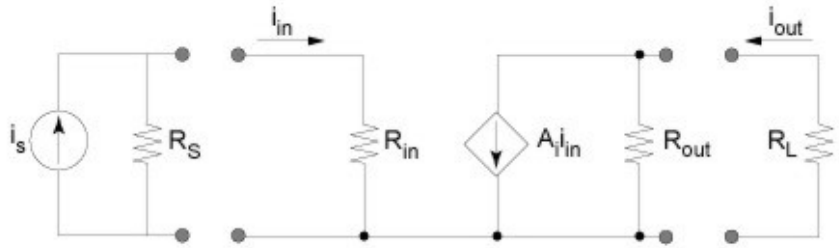
We need *methods* to find the 6 α_i parameters for the four models and equivalent circuits for unilateral two ports

Two-Port Small-Signal Amplifiers

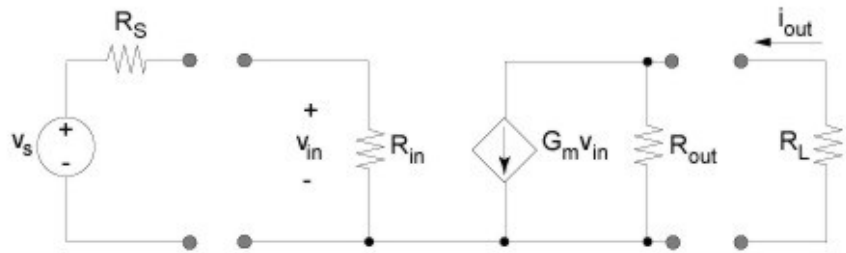
Voltage Amplifier



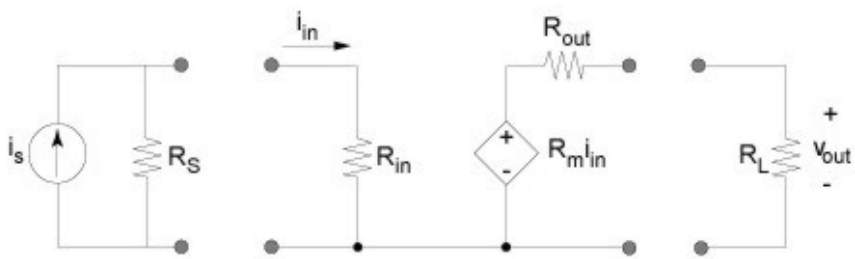
Current Amplifier



Transconductance Amplifier



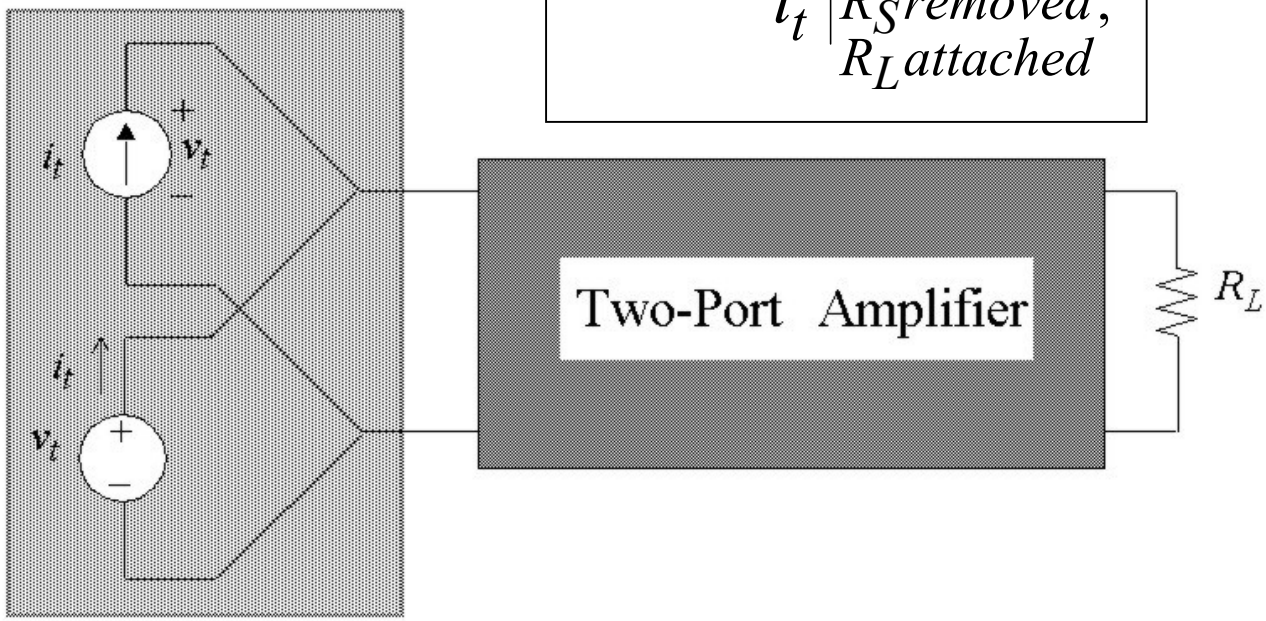
Transresistance Amplifier



Input Resistance R_{in}

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

$$R_{in} = \left.\frac{v_t}{i_t}\right|_{\substack{R_S \text{removed}, \\ R_L \text{attached}}}$$



Output Resistance R_{out}

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

$$R_{out} = \left.\frac{v_t}{i_t}\right|_{\substack{R_L removed,\\ R_S attached}}$$