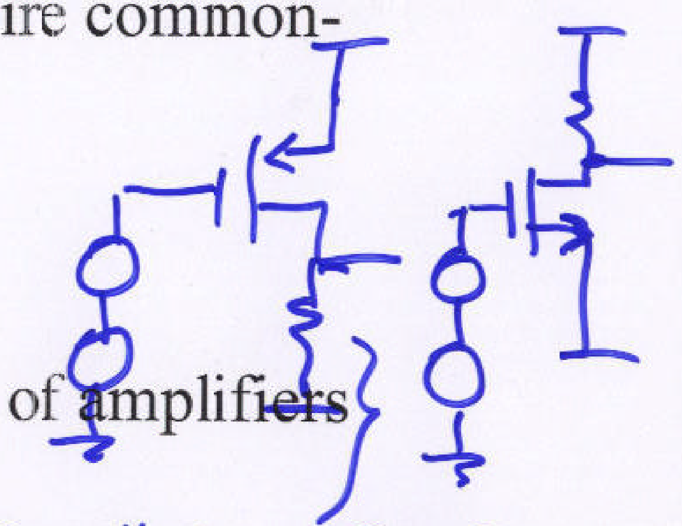
RAMP-UP TO CHAPTER 8.

Lecture 24

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



② START OF 8 MATL.

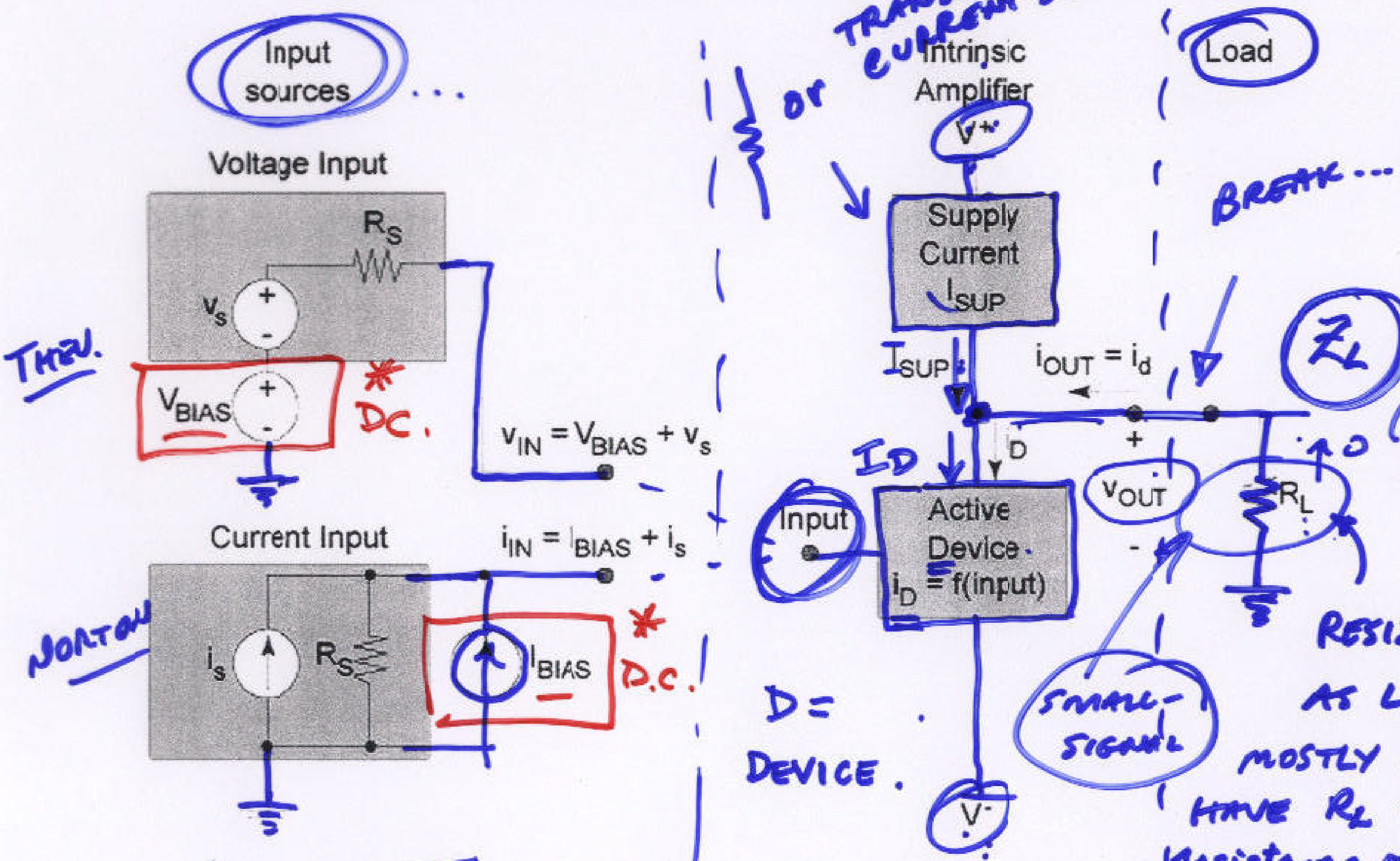
PS 9 #1. PMOS.

LECTURE 22/23 MATL.

– ABSTRACTION – STANDARD

Generalized Amplifier

REPRESENTATION

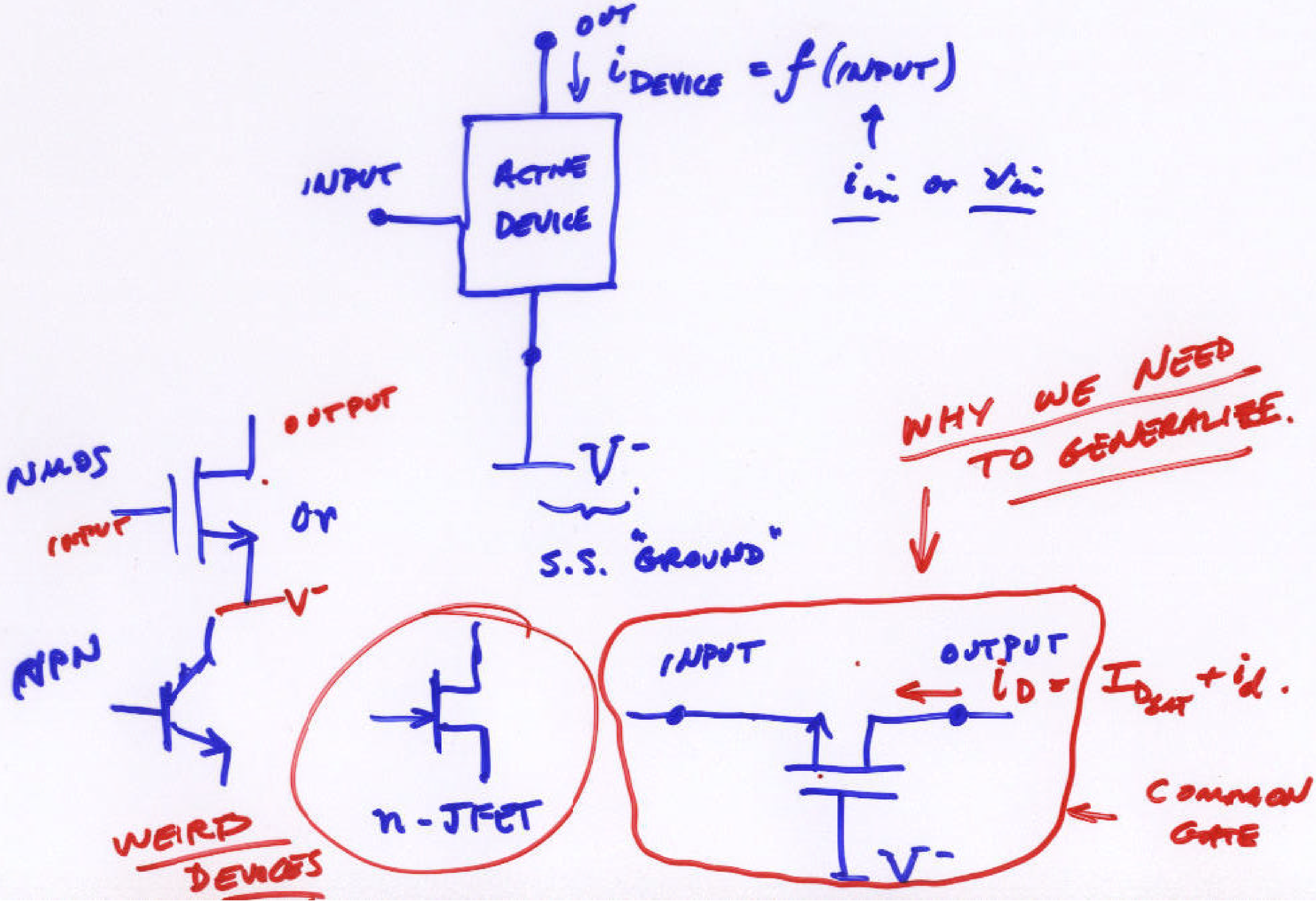


RESISTORS AS LOADS...

MOSTLY WE HAVE R_L = input resistance of next stage.

* FUTURE ... ELIMINATE THESE DC SOURCES (140/ 240)

• ACTIVE DEVICE :



Amplifier Terminology

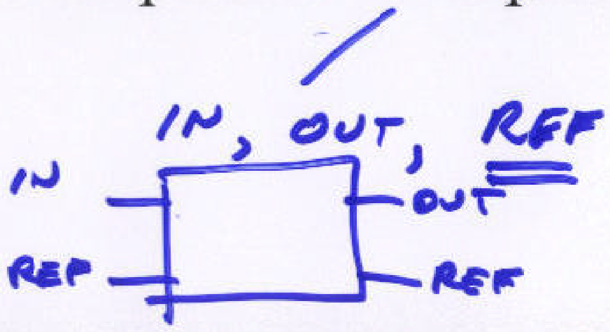
✓ *Sources*: signal, its source resistance, and bias voltage or current

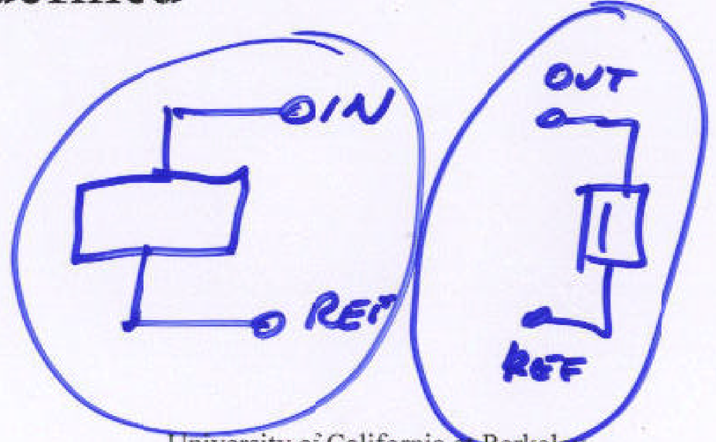
Load: use resistor in Chap. 8, but could be a general impedance ... Small-signal resistor.

" "

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

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

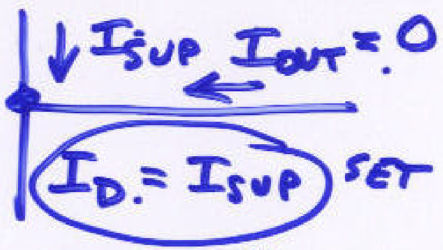




Amplifier Biasing

(PROBLEM 1: D.C.)

Select V_{IN} (or I_{IN}) to set the DC device current to equal the supply current $\boxed{I_{SUP} = I_D}$



DC output current $I_{OUT} = 0$ A.

DC output voltage $V_{OUT} =$ WHAT WE WANT ... "IN THE MIDDLE" ...

$V_{OUT} = 0V \not\Rightarrow v_{OUT}(t) = 0 = 0V.$

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

$$v_{OUT}(t) = \overset{0V}{\cancel{V_{OUT}}} + \underline{v_{out}(t)}$$

$$\boxed{v_{out} = -i_d R_L}$$

$$i_D^{(t)} = \underbrace{I_D}_{I_{SUP}} + i_d(t)$$

$$i_{OUT} = \overset{0}{\cancel{I_{OUT}}} + i_{out}$$

$$\boxed{i_{out} = i_d}$$

Math 54 Perspective

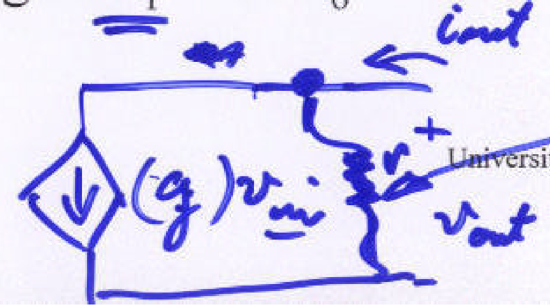
Can write linear system of equations for either i_{out} or v_{out} in terms of two of i_{in}, v_{in}, i_{out}, or v_{out}: possibilities are

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

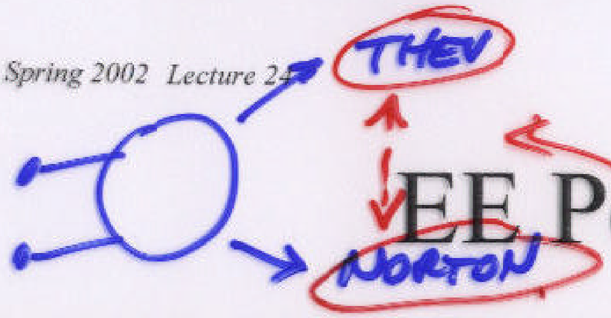
$$i_{out} = \alpha_3 i_{in} + \alpha_4 v_{out}$$

$$\left\{\begin{aligned} v_{out} &= \alpha_5 v_{in} + \alpha_6 i_{out} \\ v_{out} &= \alpha_7 i_{in} + \alpha_8 i_{out} \end{aligned}\right.$$

What is physical meaning of α_1? of α_6?



$\alpha_2 = \frac{1}{r}$



EE Perspective

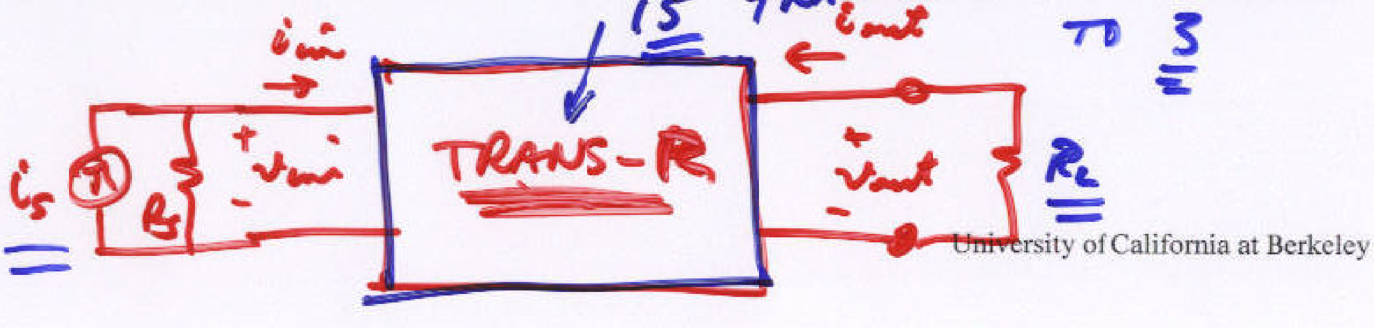
Four amplifier types: determined by the output signal and the input signal … both of which we select (usually obvious)

INTECONVERTIBLE "ON PAPER"...
LESS SO IN REALITY.

- Voltage
- Current
- Transconductance
- Transresistance

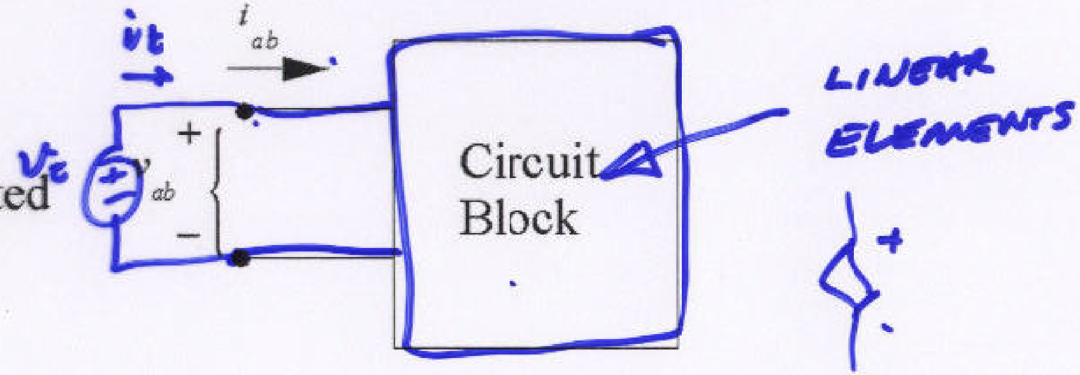
We need *methods* to find the 6 α_i parameters for the four models and equivalent circuits for unilateral two ports

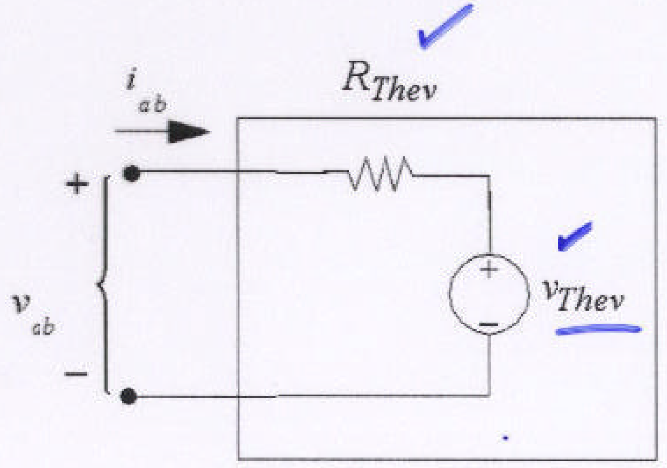
15 TRANSISTORS .... DOWN TO 3

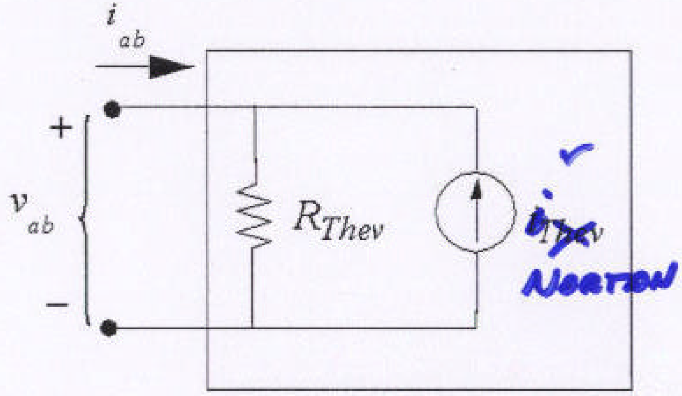


One-Port Models (EECS 40)

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

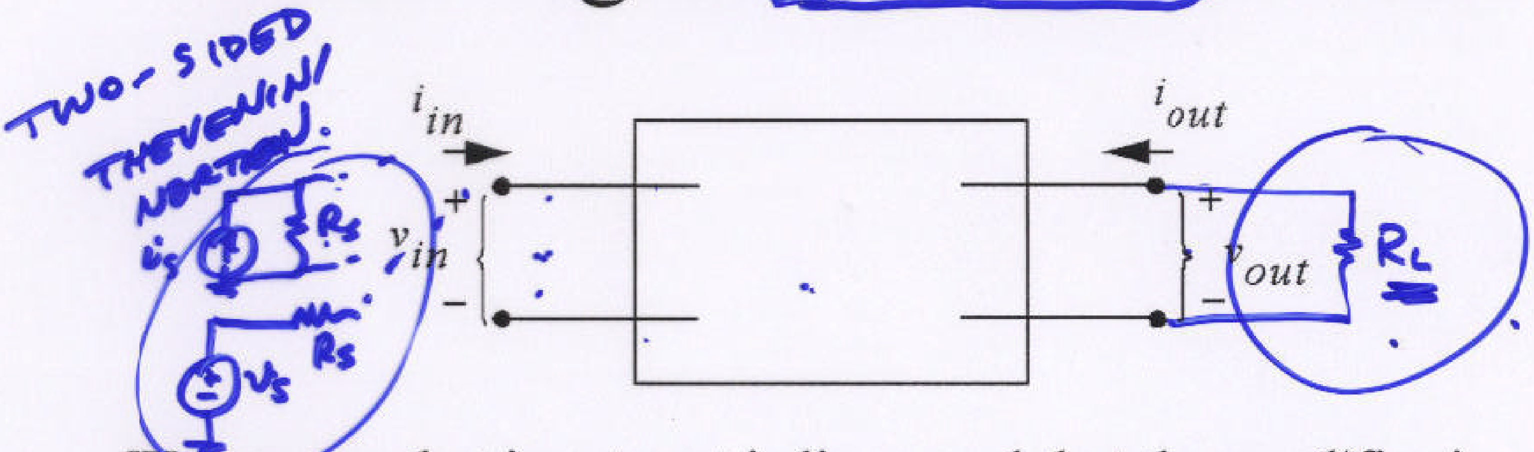






LINEARIZE

Small-Signal Two-Port Models



We assume that input port is linear and that the amplifier is *unilateral*: DON'T HAVE INPUT PORT AFFECTED BY R_L AND VICE VERSA.

APPENDIX TO CHAP. 8

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

LATER.

DON'T WORRY.

input port ... depend on i_{in}, v_{in} only

(TRUE UP TO VERY HIGH ω)