• PS 10 : [CHAPTER 8 SINGLE STAGE AMPS / 2-PORT MODELS] MOS + BJT.

Lecture 26

→ LAST PS < MIDTERM.

IMPORTANT!

- Last time:
  - Finish methods for finding two-port model parameters CS
  - Start common-source amplifier
- Today :
  - Current-source supplies
  - Common-gate amplifier ← CG

R_{in}, R_{out}

G_m – CS

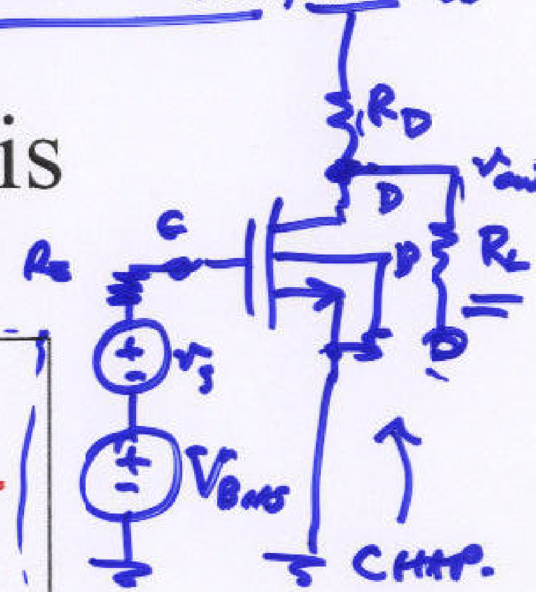
A_i – CG

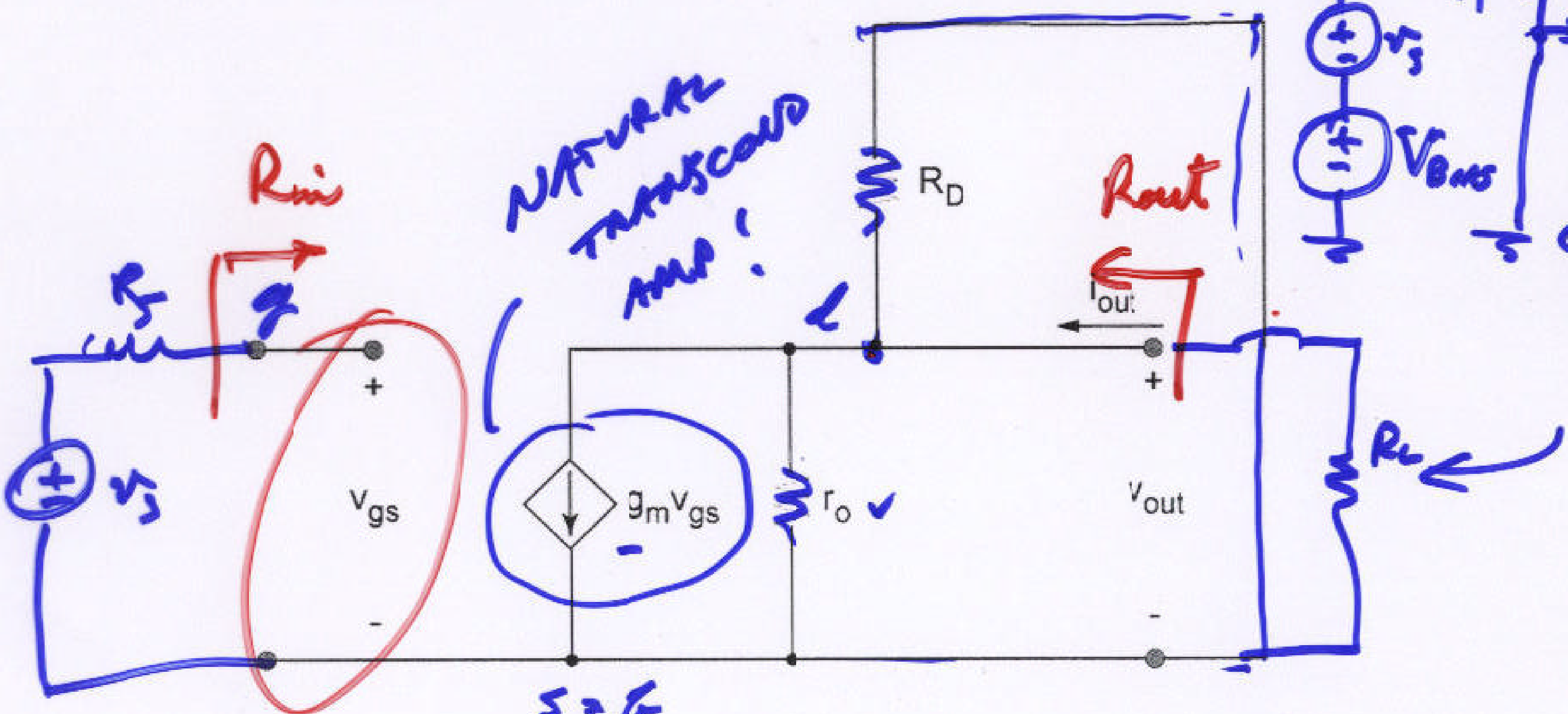
A_v – CD

• USE THESE RESULTS!

low ω. OPEN CAPS!

Small-Signal Analysis





$v_{sb} = 0.$

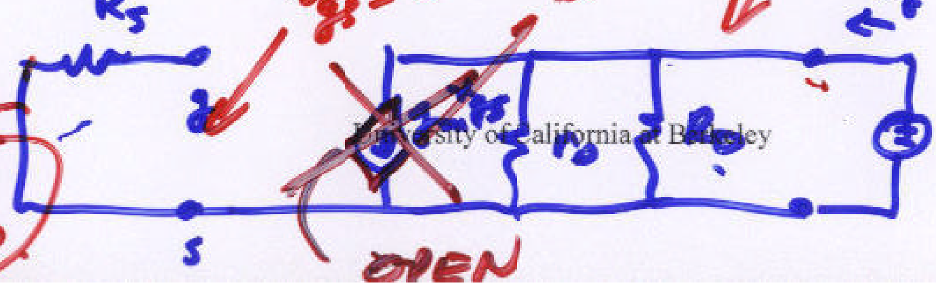
Two-Port Parameters:

Find R_{in}, R_{out}, G_m ← C.S. A_v.

✓ $R_{in} = \frac{v_t}{i_t}\Big|_{R_S=0,\ \text{left } R_L \text{ on}} = \frac{v_t}{0} = \infty$ ✓

✓ $R_{out} = \frac{v_t}{i_t}\Big|_{R_S \text{ left on},\ R_L \text{ gone (removed)}}$ ⇒

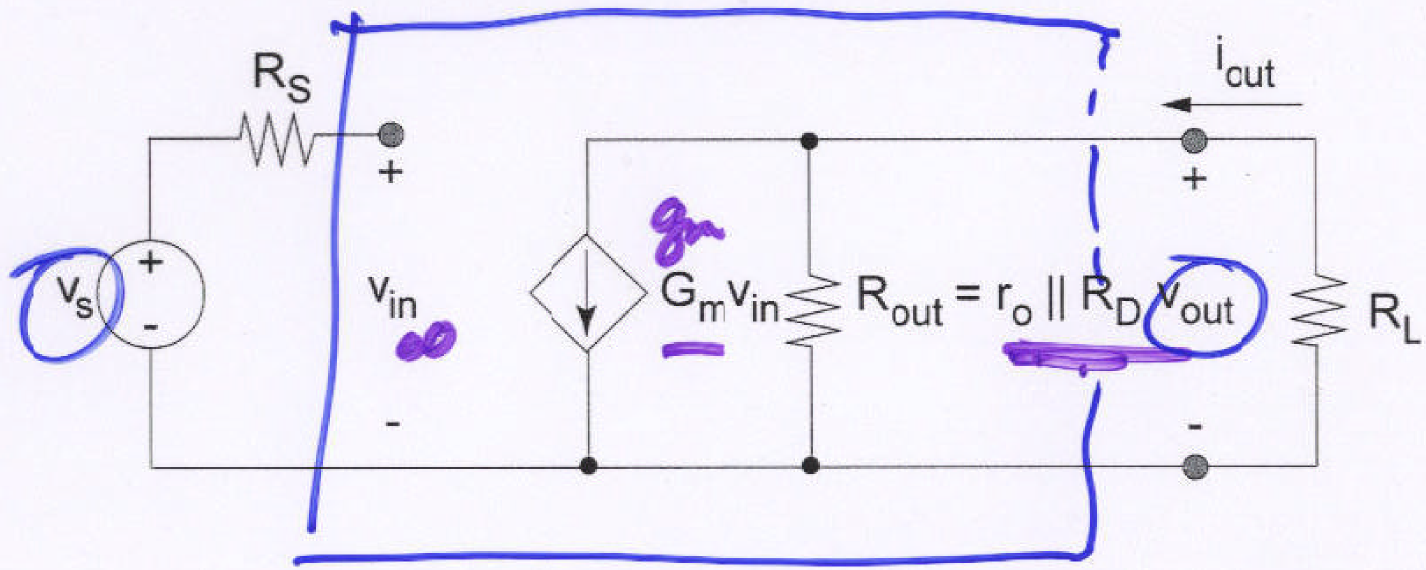
$= r_o \| R_D$



Finding $G_m = \frac{i_{out}}{v_s}\Big|_{\substack{R_s = 0 \\ R_L = 0}} = g_m$

Two-Port CS Model

Reattach source and load one-ports:



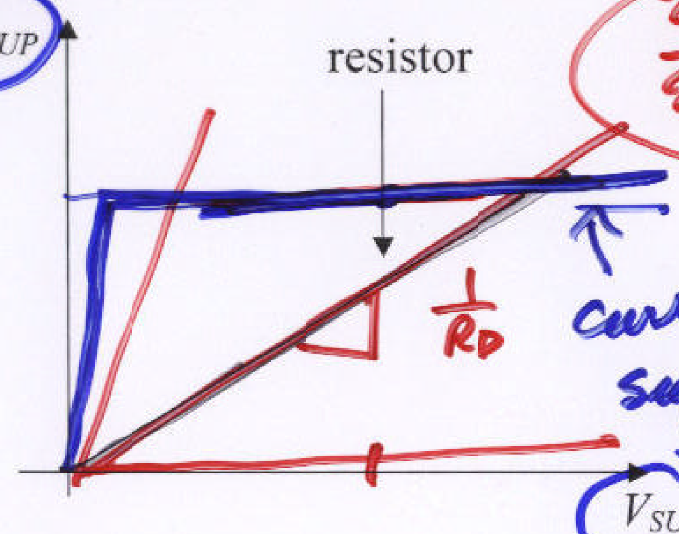
$v_{out} = -G_m [R_{out} \parallel R_L] \cdot v_s$

$A_v^* = \frac{v_{out}}{v_s} = -g_m [r_o \parallel R_D \parallel R_L]$

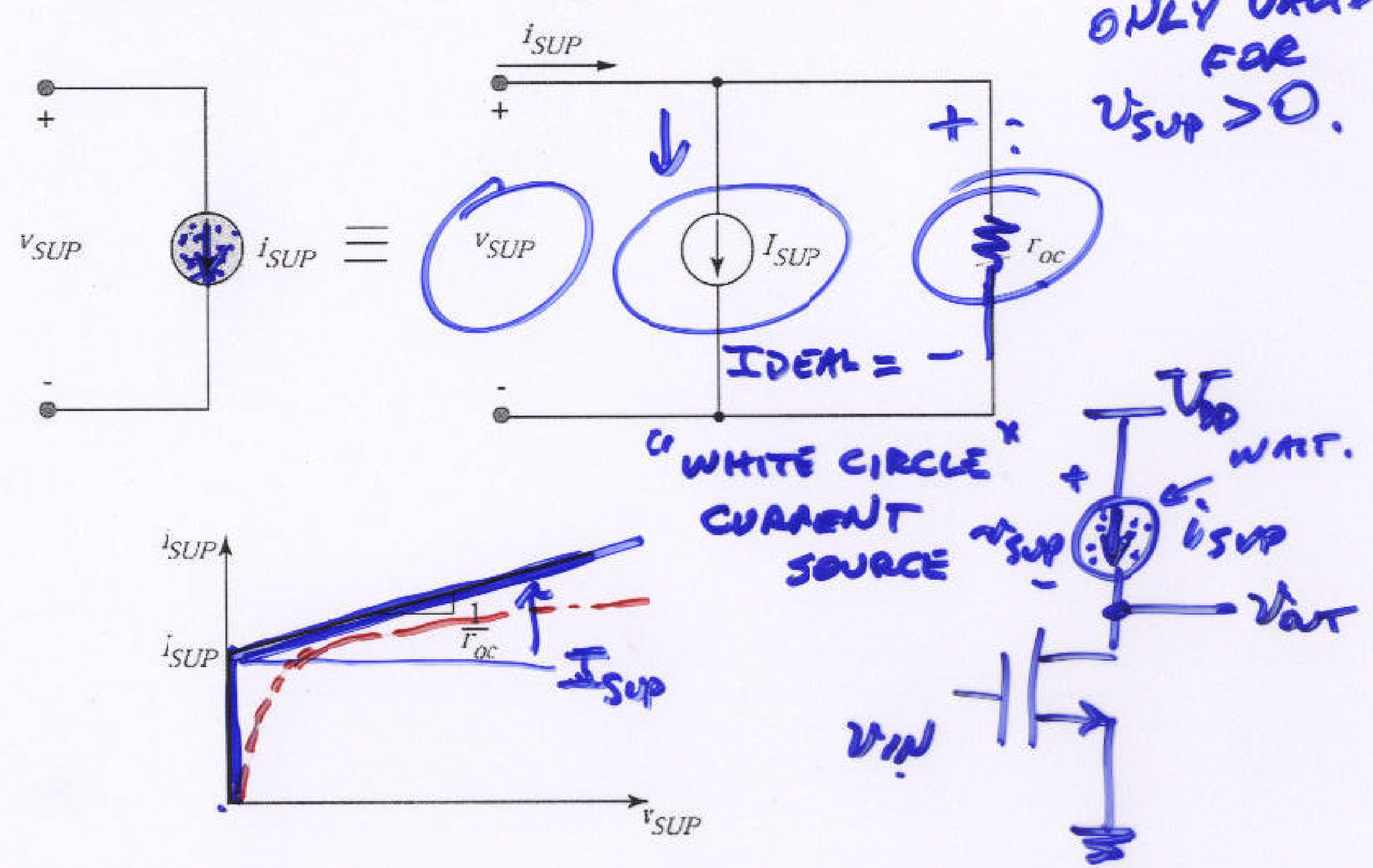
Non-Ideal Current Sources

- We want to have both R_D and a very large g_m at the same time … how to do it?

The gain depends on the small-signal resistance; the DC current can be set by a supply → modify load line

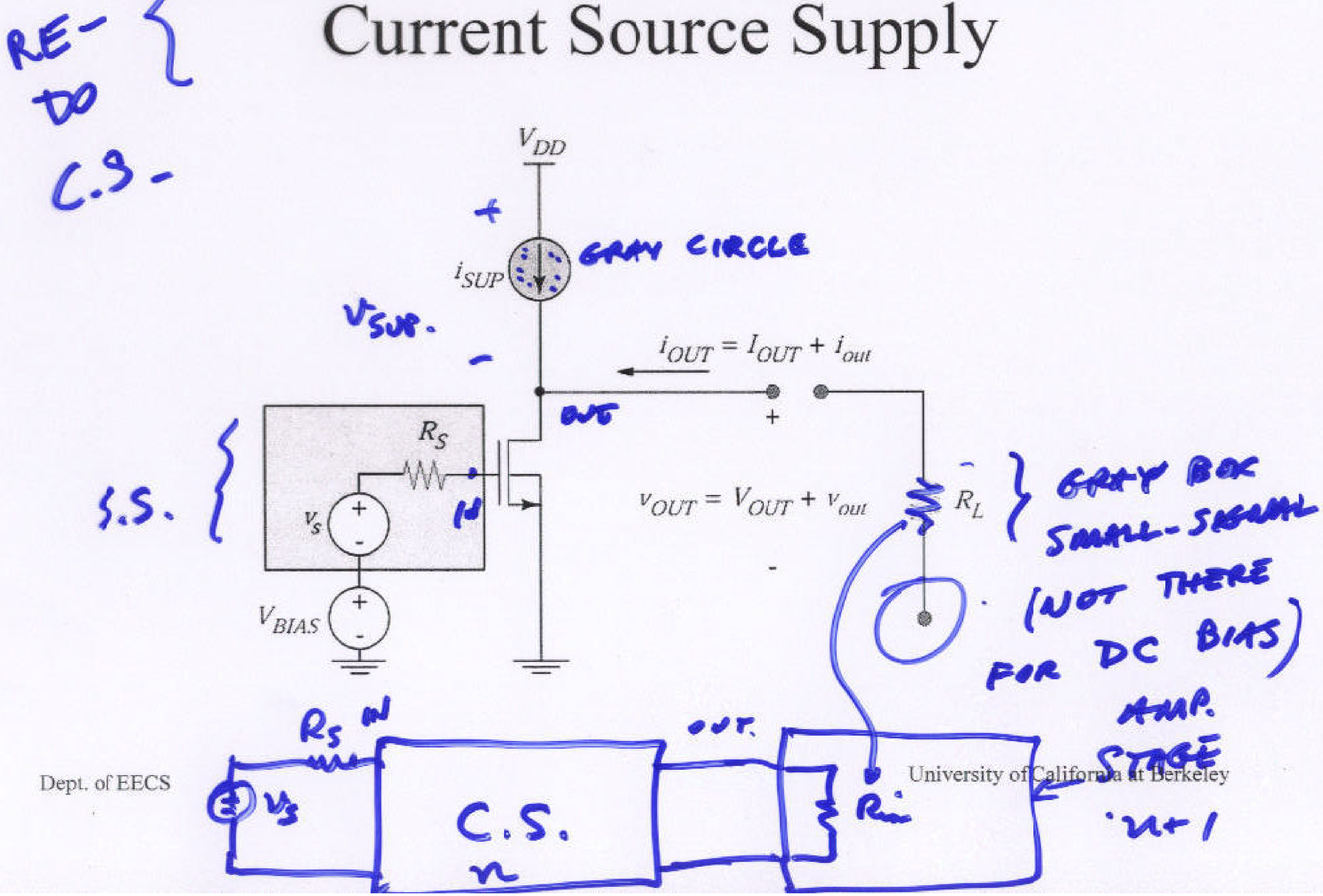


Current Source Supply

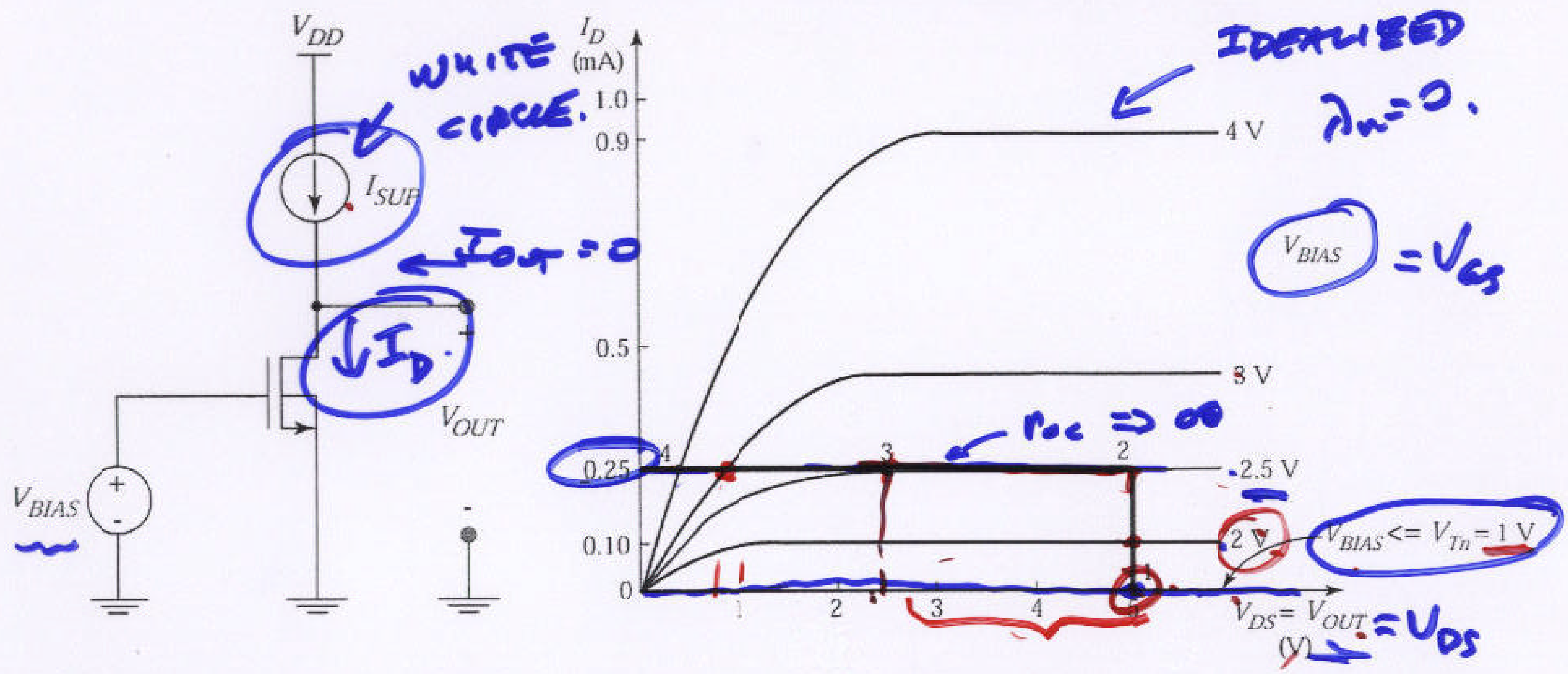


CS.

Common-Source Amplifier with Current Source Supply

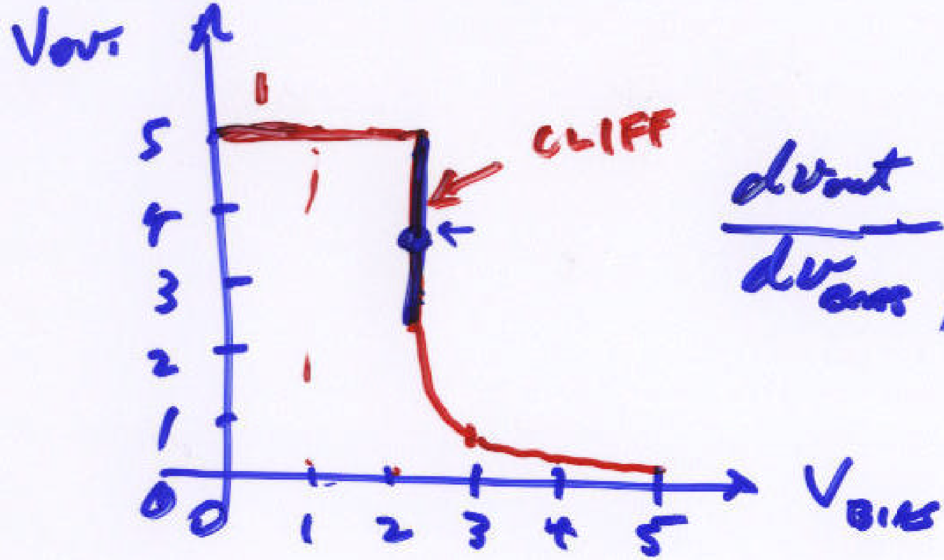


Load Line for DC Biasing



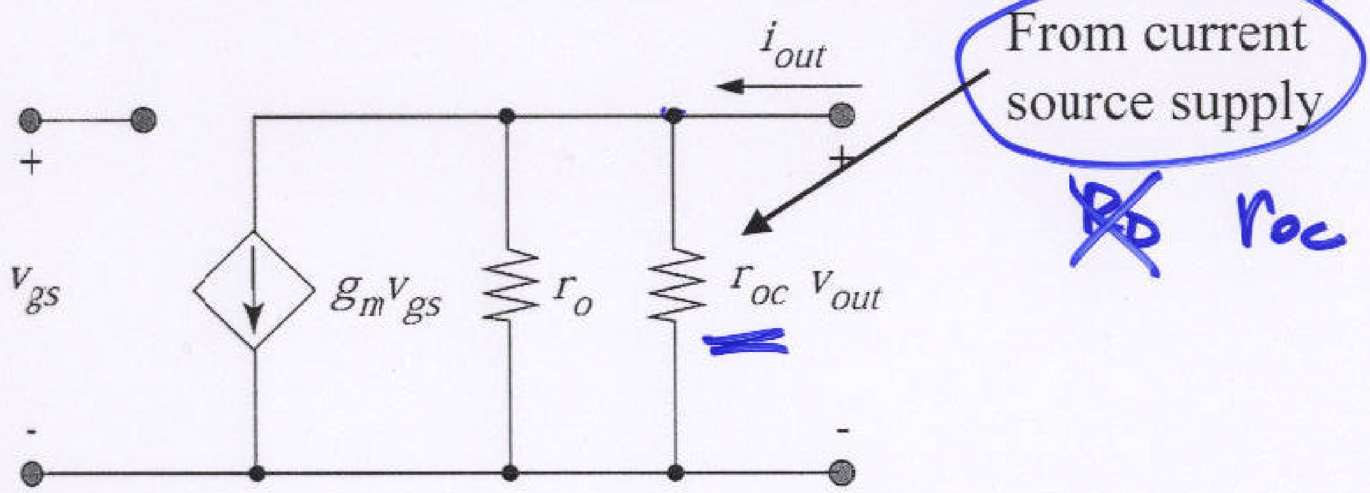
Both the I-source and the transistor are idealized for DC bias analysis

TRANSFER CURVE



$$\frac{dv_{out}}{dv_{BIAS}} \Big| = -\infty \text{ !!}$$

Two-Port Parameters

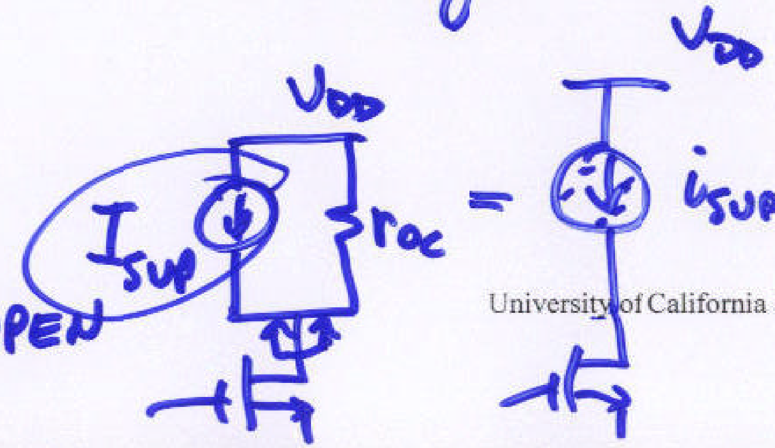


$R_{in} =$ ∞

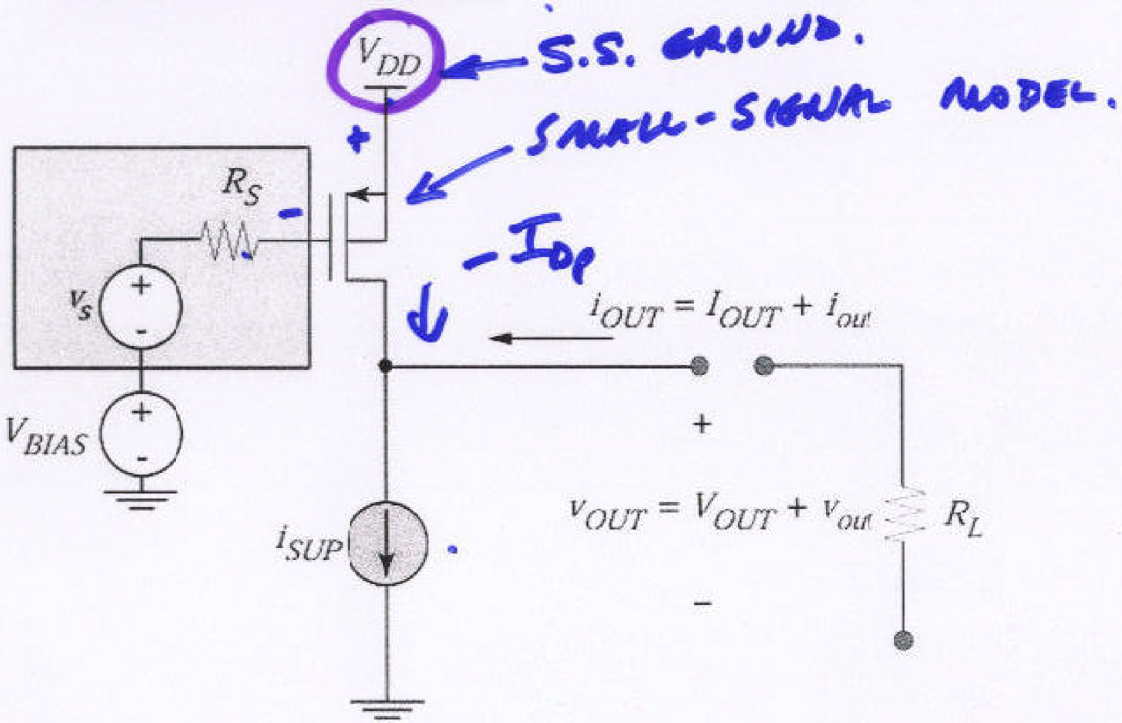
$G_m = g_m$

$R_{out} = r_o \| r_{oc}$

↑ MOSFET ↑ SUPPLY



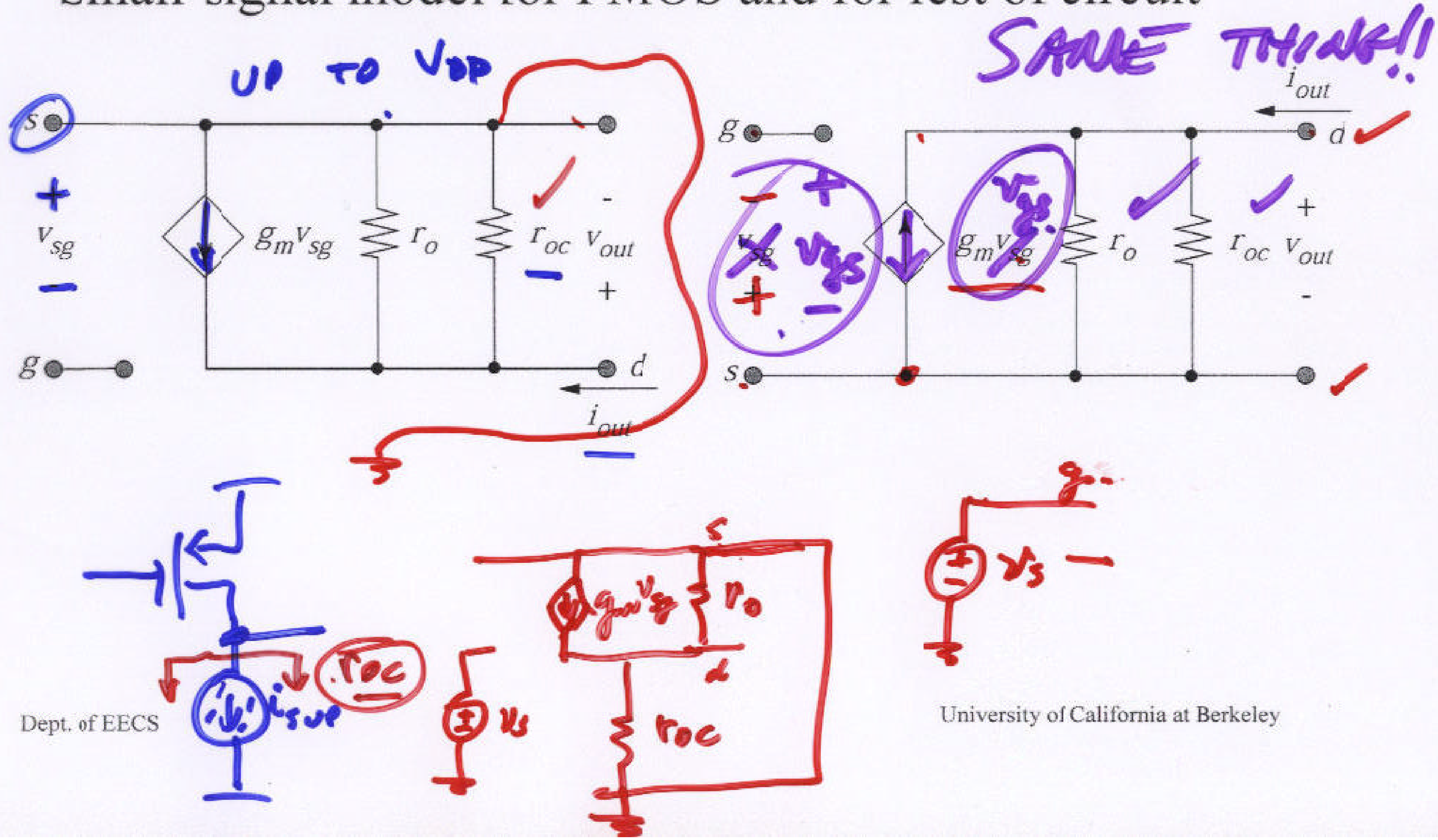
P-Channel CS Amplifier



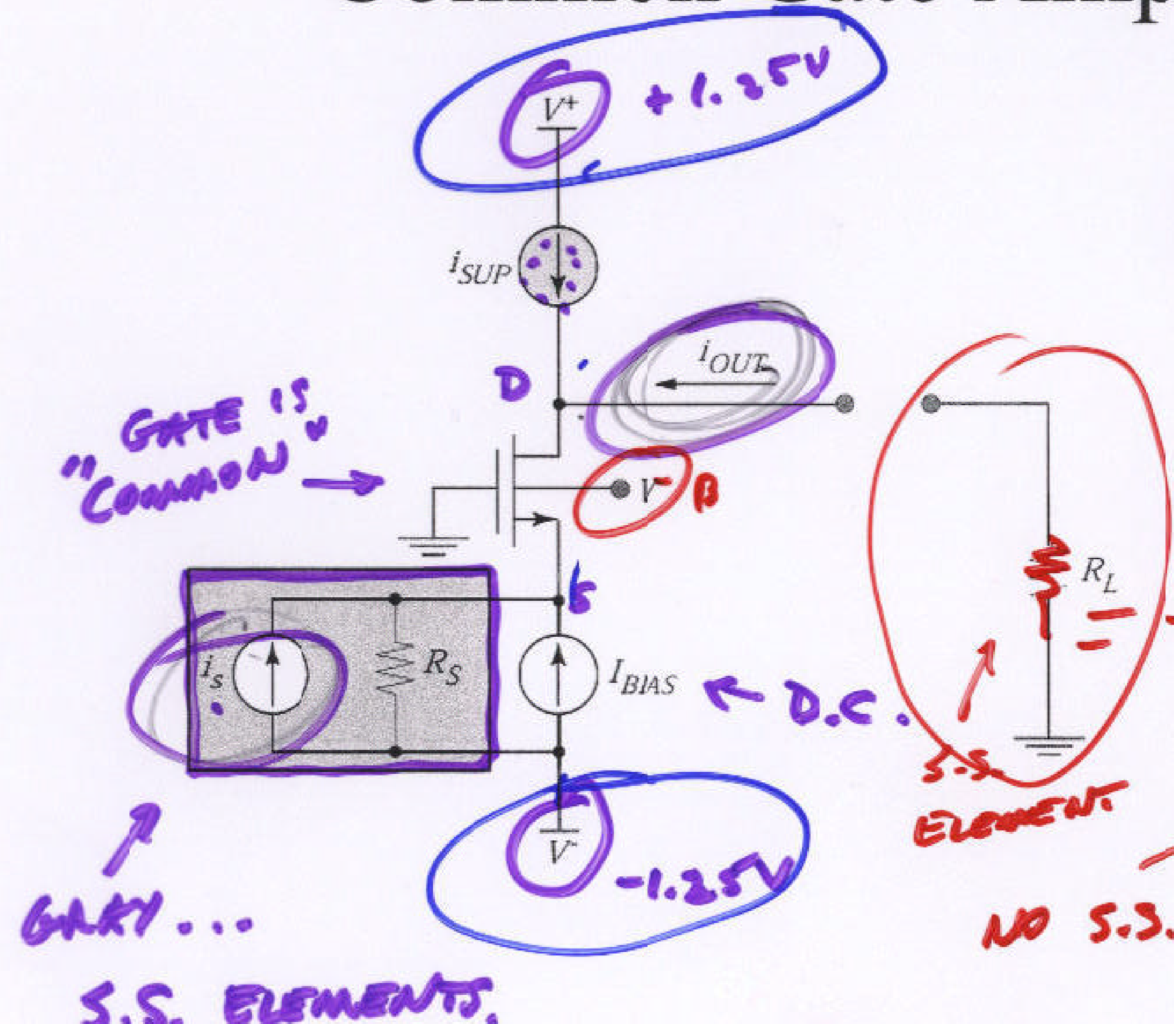
DC bias: $V_{SG} = V_{DD} - V_{BIAS}$ sets drain current $-I_{Dp} = I_{SUP}$

Two-Port Model Parameters

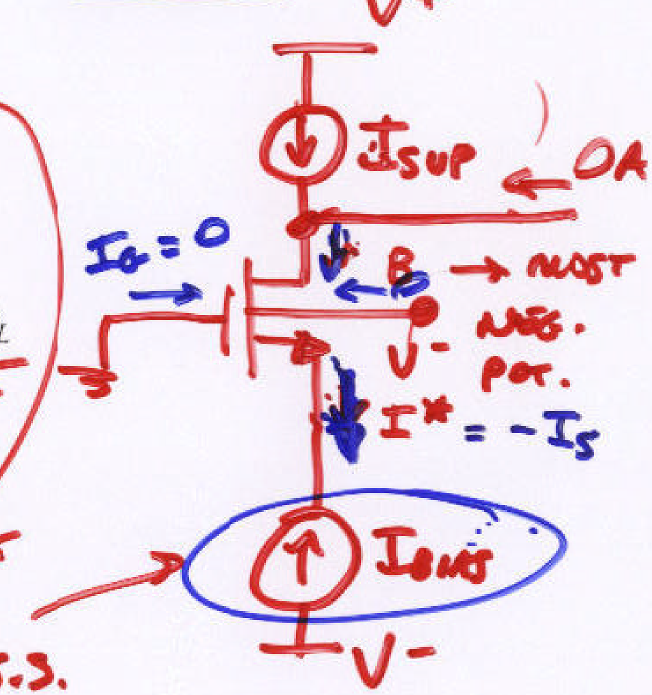
Small-signal model for PMOS and for rest of circuit



Common Gate Amplifier



DC bias:

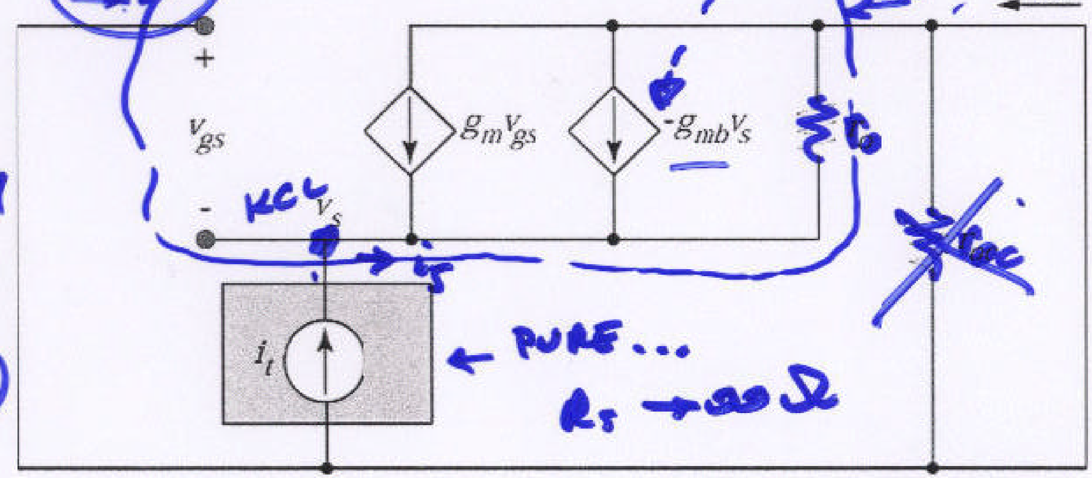


$I_{SUP} = I_D$

$I^* = I_D$

$I_{BIAS} = -I_D = -I_{SUP}$

CG as a Current Amplifier: Find A_i



$$i_{out} = i_d = -i_g - i_s = -i_t$$