

What is design?

SS model

## single pole amplifier

find linear model

- linear analysis,  
gain, gain vs. freq (Bode)
- time domain response

Design      Nonlinear effects  
                  output swing

"I need an amplifier," what species?

What gain/freq response? (current/voltage input)

What about impulsion? What is it driving? Positive kind, negative, and

What does the source look like?  
resisting, repressive, ...

How accurate does the gear need to be?

1 - 1 - 1

other swing

Done w/ device models, on to circuits

Design: from specs to devices/circuits

**Analysis:** Find operating point

(by solving rell. near a ges.)

find linear model

$$-\sqrt{5} \Rightarrow g_{m1}, r_0, C_{35}, g_{d1}, \dots$$

## Linear analysis

June 20, 1941

11 - 25

## Non-linear effects

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A hand-drawn diagram of a logic gate. It has three input lines entering from the left, each passing through a small circle representing an inverter. The outputs of these inverters enter a single OR gate symbol, which then has a single output line exiting to the right.

Winter gain

Eng respl

try response  
stability in for

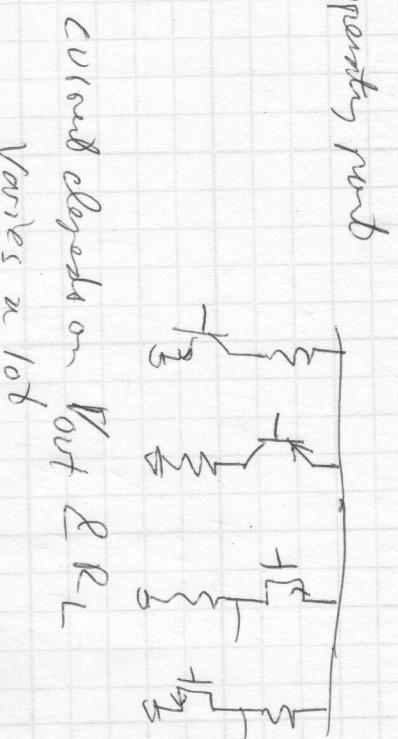
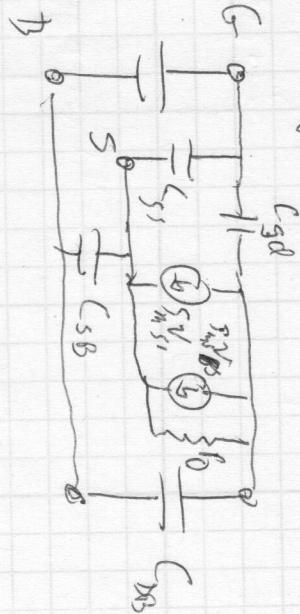
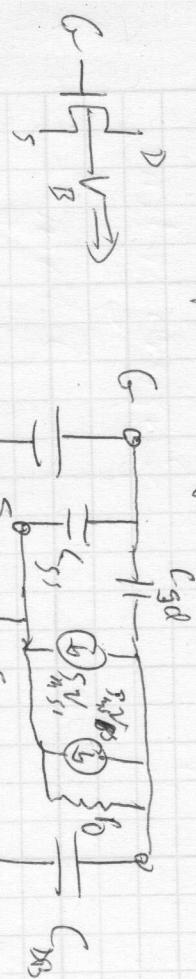
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input column

278M 051

Hoch/Eh!

MOS 1/4 length Fig 2.39



$I_D = \mu_{n\text{ox}} \frac{w}{L} (V_{ds} - V_{TH})^2 (1 + \lambda V_{ds})$

almost linear  
for bipolar, JFET,  
transistor

Same model for mos & pmos

$V_{in}$  depends on  $V_{out}$  &  $R_L$   
varies a lot

current depends on current only for bipolar  
current + geometry for mos

small signal model

-10

$V_{DS}$

$V_{out}$

$I_D$

$$I_D = \mu_{n\text{ox}} \frac{w}{L} (V_{ds} - V_{TH})^2 (1 + \lambda V_{ds})$$

↑  
process  
(may have small # of  
discrete choices)

$\lambda (L) \approx \frac{1}{L}$

$$g_m = \frac{2I_D}{V_{ov}} = \mu_{n\text{ox}} \frac{w}{L} V_{ov}$$

In general choose  $I_D$ ,  $\frac{w}{L}$ ,  $V_{ov}$  (maybe  $L$ )  
to satisfy specs  
pick any 2

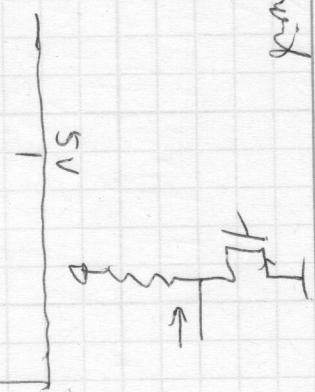
Pick  $V_i = V_T = 3V$  operate with

$$\Rightarrow V_{out} = 5V$$

$$g_m = \frac{\partial I_{out}}{\partial V_i}$$

$$V_{out} = V_{out}$$

$$V_{in} = V_{IN}$$



$$= \frac{A_I}{A_V} = -9mA / (-10mA)$$

$$B3V = (-2.0V) \\ -2.5V - (-3V)$$

$$= 10mS \text{ positive!}$$

What's the SS model for a supply?



$$V_B + V_L \Rightarrow V_L$$

more noise

$$I_B \oplus \rightarrow I_L \oplus$$

$$I_B + I_L \oplus \rightarrow I_L \oplus$$



$$I_B V_i \oplus \frac{V_o}{R_0 \| R_L}$$

nothing

raise  $V_i$  w/  $V_0 \text{ const}$

Pulls noise current out  
of the output

decreases the voltage  
on the node  
& capacitors & resistors

