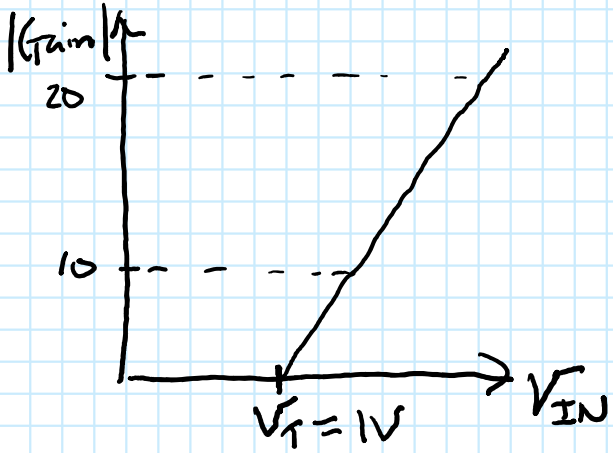
SELECTING S.S. OPERATING POINT



$$A = -g_m R_L$$
$$= -K(V_{IN} - V_T) R_L$$

$V_{DD} = 10V$, $K = 1mA/V^2$, $R_L = 10K\Omega$, $V_T = 1V$

FIND V_{IN} FOR $|A| = 12$

$$12 = 1m(V_{IN} - 1)10K$$

$$V_{IN} = 2.2V$$

What is maximum v_{pp} for v_{in}

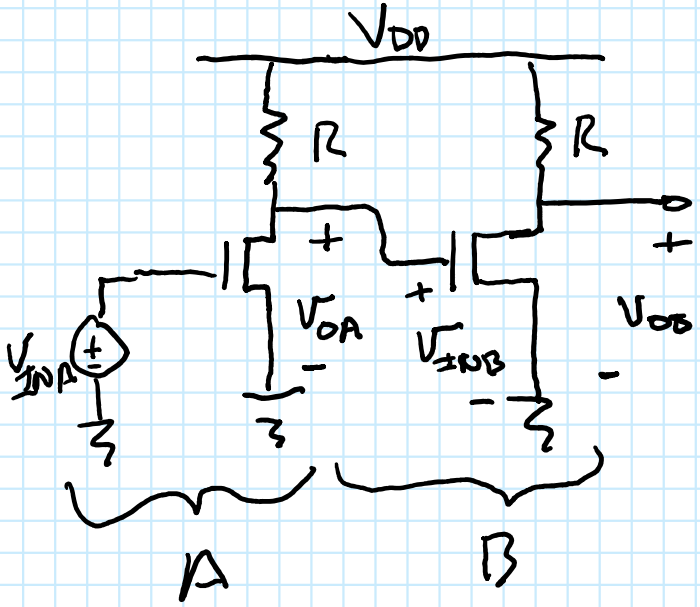
max p-p $(2.32 - 2.2) \times 2$
$= 0.24 V_{pp}$

FROM CHAP 7

$$\frac{-1 + \sqrt{1 + 2V_{DD}R_L K}}{R_L K} + V_T \geq V_{IN} \geq V_T$$

$$2.32V \geq V_{IN} \geq 1$$

TWO-STAGE AMP



$$A_A \times A_B$$

$$\frac{V_{OB}}{V_{INA}} = \frac{V_{OA}}{V_{INA}} \times \frac{V_{OB}}{V_{INB}}$$

$V_{INA} = 2.2V$

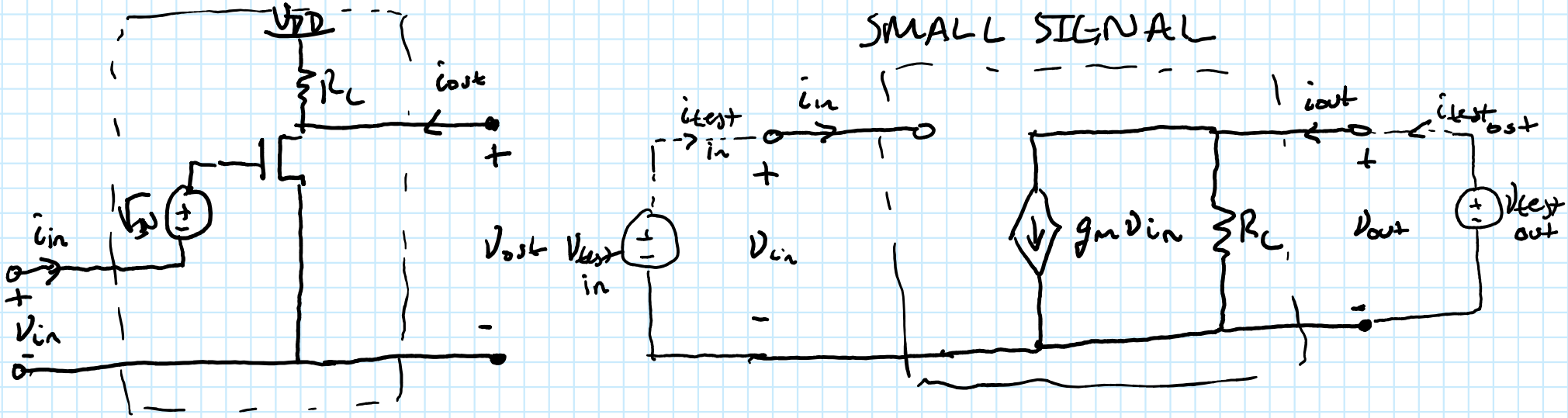
$$V_{OA} = V_{DD} - I_{DA}R$$

$$= V_{DD} - \frac{K}{2}(V_{INA} - V_T)^2 R$$

$$= 10 - \frac{1}{2}(2.2 - 1)^2 10$$

$= 2.8V > 2.32 \rightarrow$ NOT A VALID OPERATING POINT FOR B

INPUT & OUTPUT RESISTANCE, CURRENT AND POWER GAIN



INPUT RESISTANCE r_i

- Change in input current for a small change in input voltage

① apply small v_{test}, measure i_{test}

② all other independent voltage sources are shorted
current sources are opened

$$r_{in} = \frac{v_{test\,in}}{i_{test\,in}} = \frac{v_{test}}{0} \Rightarrow \infty$$

$$r_{out} = \frac{v_{test\,out}}{i_{test\,out}} = R_L \Rightarrow \text{MOSFET behaves like open circuit } i_d = 0$$

CURRENT GAIN

$$\frac{\text{incremental change in output current}}{\text{incremental change in input current}}$$

FOR A GIVEN LOAD RESISTANCE

Apply V_{test} → measure i_{test} & i_{out}

$$\text{current gain} = \frac{i_{out}}{i_{test}}$$

$$i_{out} = \frac{V_{out}}{R_o}, \quad i_{test} = \frac{V_{test}}{R_i} \Rightarrow \text{ratio} = \underbrace{\frac{V_{out}}{V_{test}}}_{\text{voltage gain}} \cdot \frac{R_i}{R_o}$$

lower gain with external R_o

$$\frac{V_{out}}{V_{test}} = -\frac{g_m V_{test} (R_L \| R_o)}{V_{test}} = -g_m (R_L \| R_o)$$

$$\text{current gain} = -g_m (R_L \| R_o) \frac{R_i}{R_o}$$

if $R_i = \infty$ (MOSFET) → C.G. → ∞

POWER GAIN

POWER GAIN ⇒ ratio of $\frac{\text{power supplied to an external load}}{\text{power supplied by input source}}$

USE SAME CIRCUIT AS CURRENT GAIN (R_i, R_o)

$$\text{Power Gain} = \left(\frac{V_{out}}{V_{test}}\right)\left(\frac{i_{out}}{i_{test}}\right) = \frac{P_{out}}{P_{in}}$$

Voltage gain | current gain

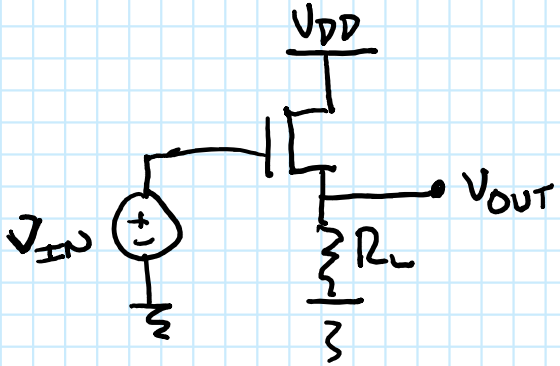
$$= -g_m(R_L \| R_o) \cdot \left[-g_m(R_L \| R_o)\frac{R_i}{R_o}\right]$$

$$= g_m^2 (R_L \| R_o)^2 \frac{R_i}{R_o}$$

if $R_i = \infty$

$R_G = \infty$ → doesn't matter if R_i is finite

COMMON DRAIN AMP
(AKA SOURCE FOLLOWER)



$K = 2\frac{mA}{V^2}$

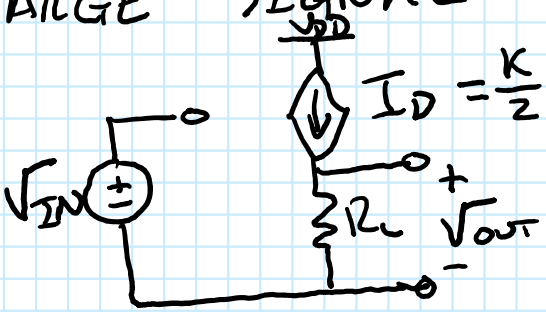
$V_T = 1V$

$R_L = 1k\Omega$

$V_{IN} = 2V$

↳ BUFFER $A \sim 1$

① LARGE SIGNAL



$I_D = \frac{K}{2}(V_{GS} - V_T)^2$

V_{GS}?

$V_{GS} = V_G - V_S$

$= V_{IN} - V_{OUT}$

FIND V_{OUT}, I_D

$V_{OUT} = \frac{K}{2}(V_{GS} - V_T)^2 R_L$

$= \frac{K}{2}(V_{IN} - V_{OUT} - V_T)^2 R_L$

$= \frac{2}{2}(2V - V_{OUT} - 1)^2 1K$

$V_{OUT} = (1 - V_{OUT})^2$

$V_{OUT} = 1 - 2V_{OUT} + V_{OUT}^2$

$V_{OUT}^2 - 3V_{OUT} + 1 = 0$

$V_{OUT} = \frac{3 \pm \sqrt{9-4}}{2} = \frac{3 \pm 2.23}{2}$

$V_{OUT} = 2.6$ or $0.4V$

CHECK NOT CUTOFF

$V_{GD} \geq V_T$

$V_{IN} - V_{OUT} \geq V_T$

$V_{OUT} = 0.4V$

$I_D = \frac{V_{OUT}}{R_L} = \frac{0.4}{1k\Omega} = 0.4mA$