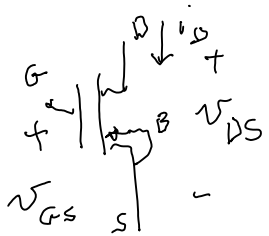
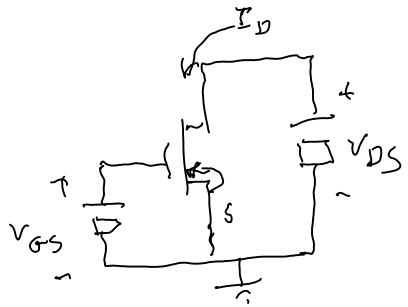
ENEE 303
02/07/19

Note Title 3/7/2019

In saturation : $i_D \approx \frac{K_p}{2}\frac{W}{h}\left(v_{GS} - V_{th}\right)^2\left(1 + \lambda v_{DS}\right)$

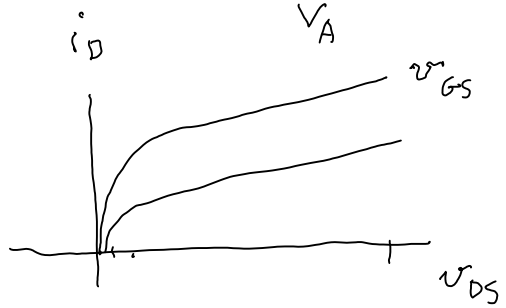
$\lambda = \frac{1}{V_A} = 15m = 15 \times 10^{-3} = 0.015$





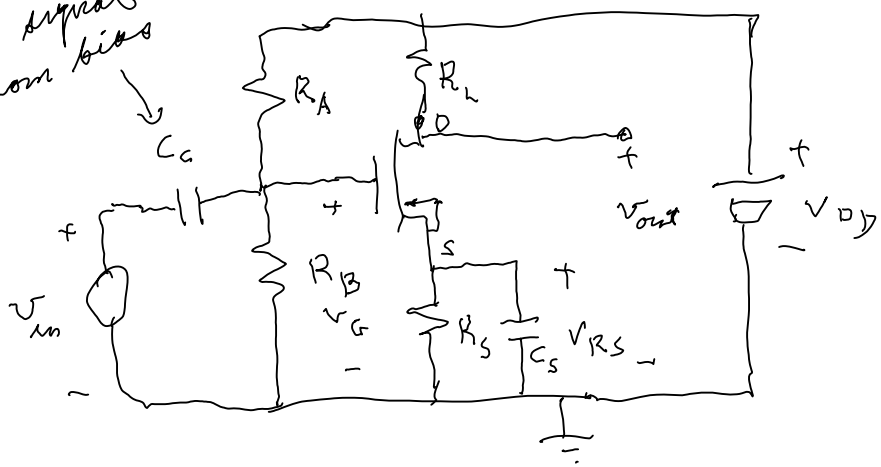
CS

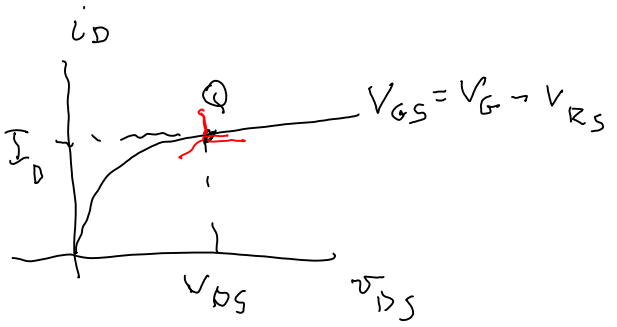
for Spice



Spice

isolates signal source from bias





$$\frac{v_{out}}{v_{in}} = A_v \simeq -g_m R_L \qquad g_m \simeq \frac{2 I_D}{(V_{GS} - V_{th})}$$

$$V_G = \frac{R_B}{R_A + R_B} \cdot V_{DD} = \frac{1}{\frac{R_A}{R_B} + 1} \cdot V_{DD}$$

C_C & C_S = shorts for signal

desire $R_S \to 0$ for signal do by use of C_S $\simeq R_S \,//\, \frac{1}{C_S s} \simeq$ $Y(s)$ at S $= \frac{1}{R_S} + C s \simeq \frac{1}{R_S} + j\omega$

@ DS $\to \omega = 0$ $Y_S(0) = \frac{1}{R_S}$ bias

$Y(j\omega) = G_S + jC\omega \Rightarrow |Y_s(j\omega)| = \sqrt{G_S^2 + (C\omega)^2} \Rightarrow$ for signal the impedance seen by the source has $|Z_s(j\omega)| = \frac{1}{|Y(j\omega)|} = \frac{1}{\sqrt{G_S^2 + (C^2\omega^2)}}$

as $\omega >> 0$, $|Z_s(j\omega)| \sim 0$

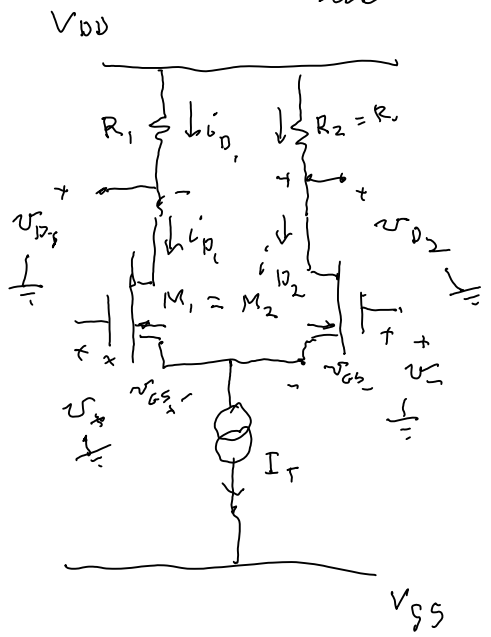
puts a short on source to ground $\Rightarrow$ CS amplifier

use large C_S

OTA

P.646
Fig 9.33

Fig 9.26
P.638



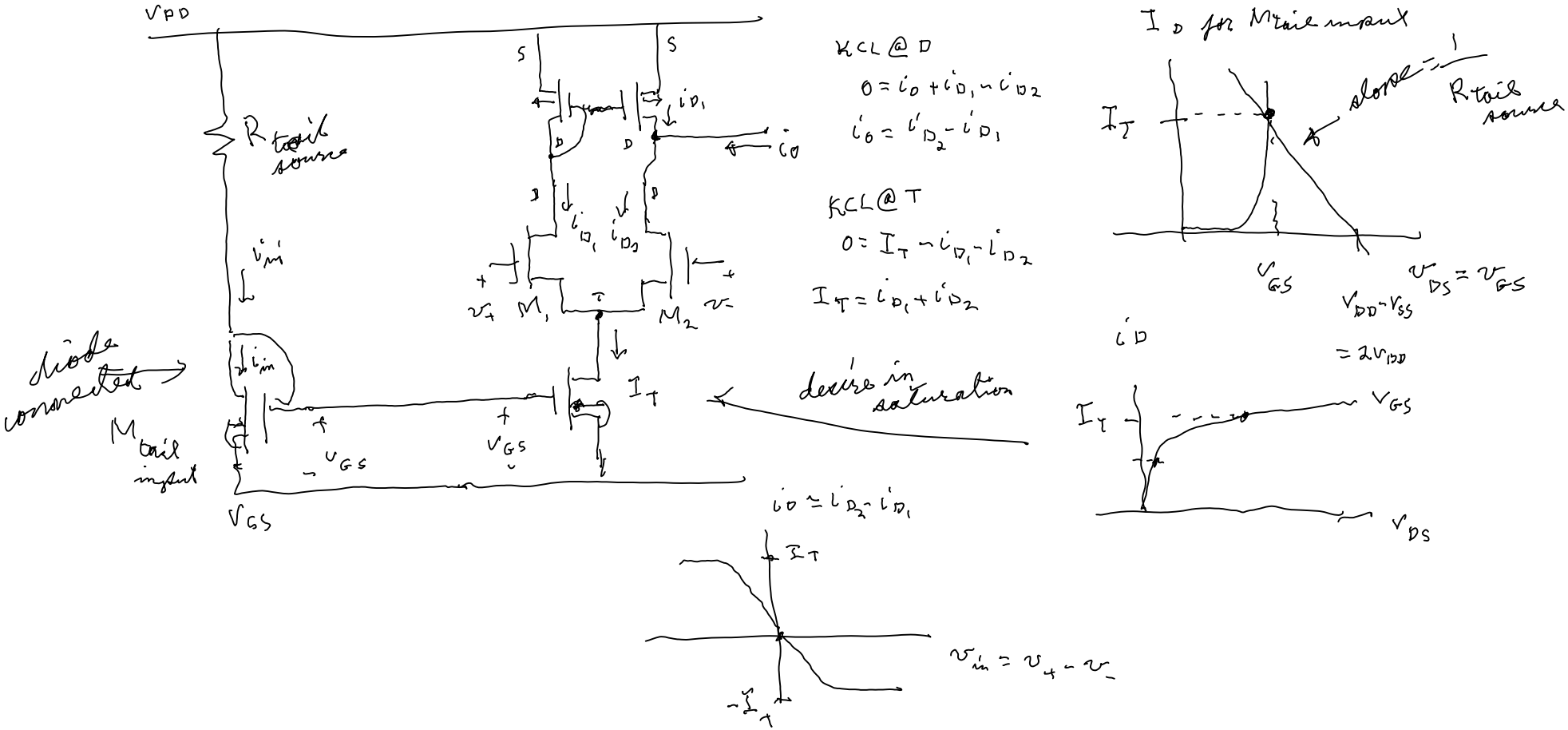
Since $I_T = I_{DC}$

@ S: KVL $\Rightarrow 0 = -v_+ + v_{GS_+} - v_{GS_-} + v_-$

$v_+ - v_- = v_{GS_+} - v_{GS_-} \Rightarrow v_{difference} = v_{in}$

@ D: KVL $\Rightarrow 0 = -v_{D_1} - R_1 i_{D_1} + R_2 i_{D_2} + v_{D_2}$

$v_{D_1} - v_{D_2} = R_1(i_{D_2} - i_{D_1})$, $R_2 = R_1$

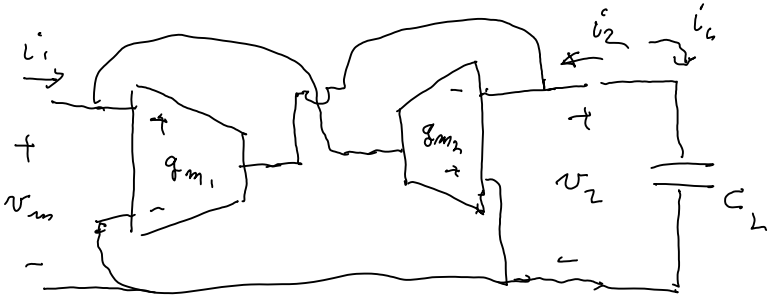

VDD
R tail source
S
S
D
D
i_{D_1}
i_O
i_{in}
v_+
M_1
M_2
v_-
diode connected
M_{tail} input
I_T
desire in saturation
$-v_{GS}$
v_{GS}
v_{GS}
KCL @ D
$0 = i_O + i_{D_1} - i_{D_2}$
$i_O = i_{D_2} - i_{D_1}$
KCL @ T
$0 = I_T - i_{D_1} - i_{D_2}$
$I_T = i_{D_1} + i_{D_2}$
I_D for M_{tail} input
I_T
slope = 1
R tail source
v_{GS}
$v_{DS} = v_{GS}$
$V_{DD} - V_{SS}$
$= 2V_{DD}$
i_D
I_T
V_{GS}
V_{DS}
$i_O = i_{D_2} - i_{D_1}$
I_T
$-I_T$
$v_{in} = v_+ - v_-$

small signal $i_o = g_m v_{in}$

$$i_1' = g_{m_2}(-v_2)$$

$$i_L = sC_L v_2 \Rightarrow v_2 = +\frac{i_L}{sC_L}$$

$\Bigg\} \rightarrow \equiv$



gyrator

$$i_1 = -g_{m_2}\cdot\frac{i_L'}{sC_L}, \quad i_2 = -i_2'$$

$$= -g_{m_2}(-i_2') = \frac{g_{m_2}}{sC_L}; \quad i_2' = g_{m_1} v_{in} \Rightarrow i_1 = +\frac{g_{m_2}}{sC_L}\cdot g_{m_1} v_{in}$$

$$i_1' = \frac{i_{in}}{v_{in}} = \frac{g_{m_2} g_{m_1}}{sC_L} = Y_{in}(s); \quad Z_{in}(s) = \frac{1}{g_m} = \frac{C_L}{g_{m_1} g_{m_2}}\cdot s \Leftarrow \text{an inductor}, \; L = \frac{C_L}{g_{m_1} g_{m_2}}$$