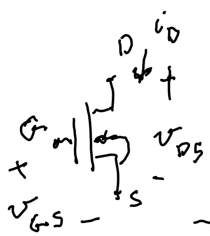
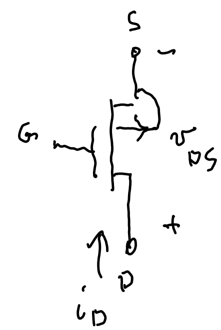
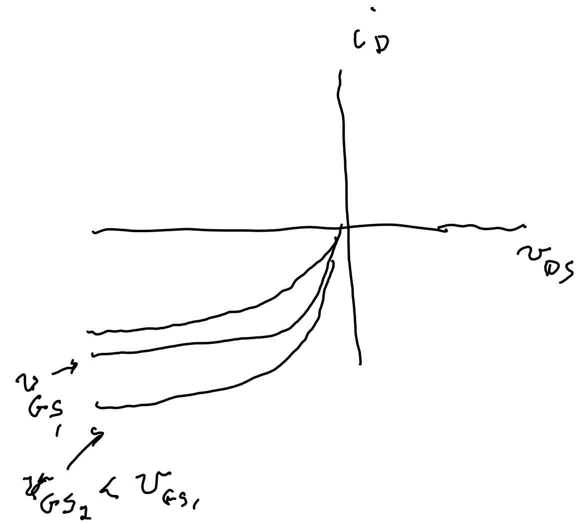
ENEE 303
02/12/19

Note Title 2/12/2019

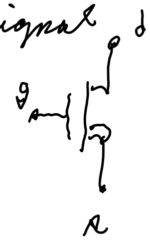
Key ideal result $A_v \doteq \frac{v_{out}}{v_{in}} \approx -g_m R_L$ & need bias

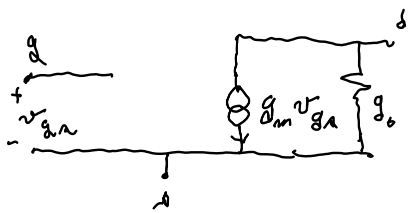


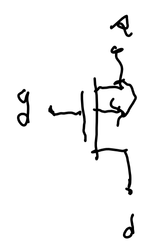


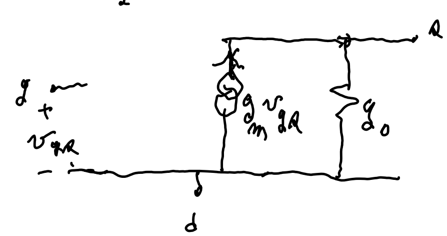


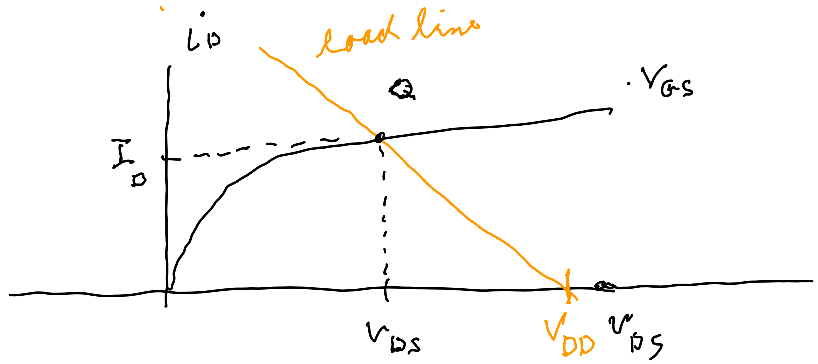
small signal

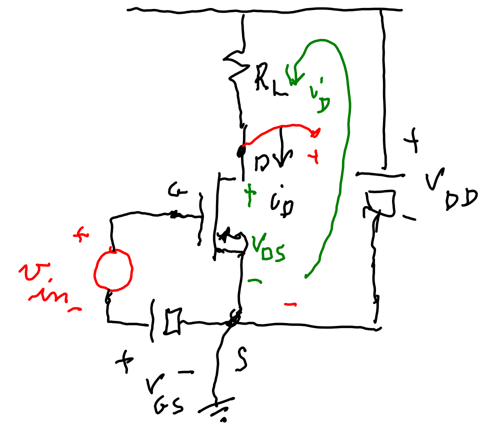






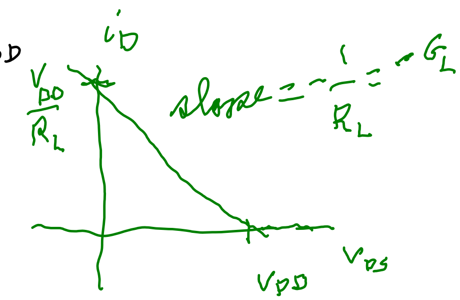






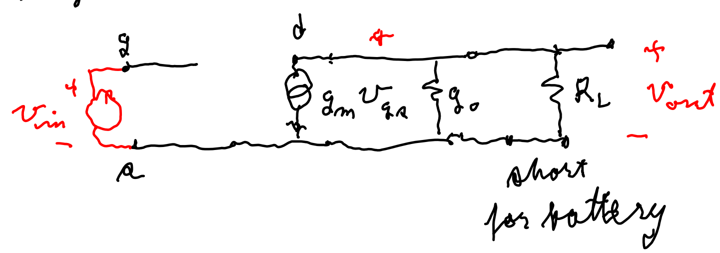
$V_{DS} = -R_L i_D + V_{DD}$

load line



slope $= -\frac{1}{R_L} = -G_L$

small signal



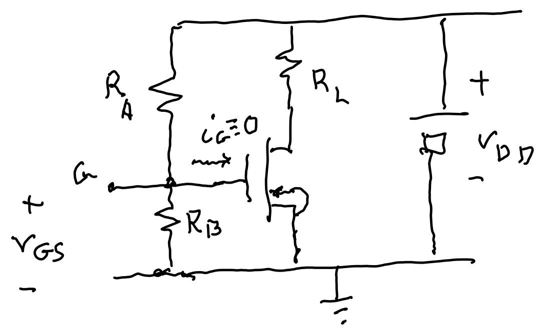
$$v_{out} = -\frac{1}{g_o + G_L} \cdot i_d = \frac{-g_m}{g_o + G_L} \cdot v_{in}$$

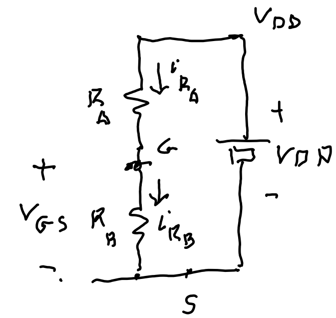
$$\frac{v_{out}}{v_{in}} = -\frac{g_m}{g_o + G_L} \qquad \text{if } g_o = 0 \Rightarrow -\frac{g_m}{G_L} = -g_m R_L$$

Ex: if $g_m = 10^{-3}\,\mho$ & $R_L = 2\,K\Omega$

$-g_m R_L = -2 \Rightarrow |A_v| = 2$ a gain

Biasing:





$$i_{R_A} = i_{R_B} = \left[\frac{1}{(R_A + R_B)}\right] V_{DD}$$

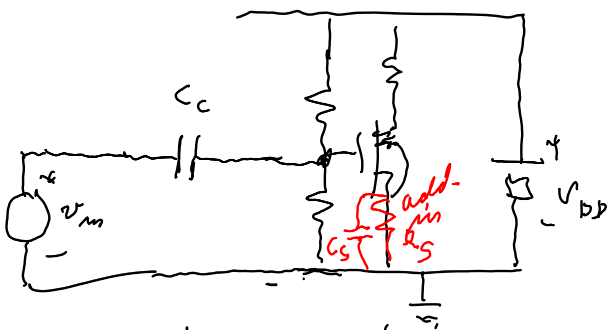
$$V_{GS} = R_B \cdot i_{R_B} = \frac{R_B}{R_a + R_b} \cdot V_{DD} = \frac{1}{1 + \frac{R_A}{R_B}} \cdot V_{DD}$$

Choose one of R_A, R_B large say $1\ \text{Meg-}\Omega = 10^6\ \Omega$

Ex: $V_{GS} = 3V$ & $V_{DD} = 9V$ choose $R_B = 1\ \text{Meg}\Omega$

$\Rightarrow$ find $R_A \Rightarrow \left(1 + \frac{R_A}{R_B}\right) V_{GS} = V_{DD} \Rightarrow \frac{R_A}{R_B} = -1 + \frac{V_{DD}}{V_{GS}}$

$= -1 + \frac{9}{3} = 2 \Rightarrow R_A = 2 \times R_B = 2\ \text{Meg}\Omega$

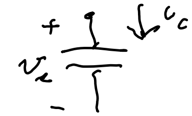


C_C isolates bias

R_S to compensate temperature change, C_S to isolate bias

C_C = coupling cap.

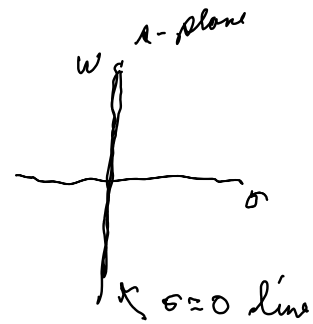
$i_c = C \frac{dv_c}{dt}$



$= C s v_c$

$s = \frac{d}{dt}$ derivative operator

also goes with $V_c e^{st} = v_c(t)$



where $s = \sigma + j\omega$

also as s in the Laplace transform

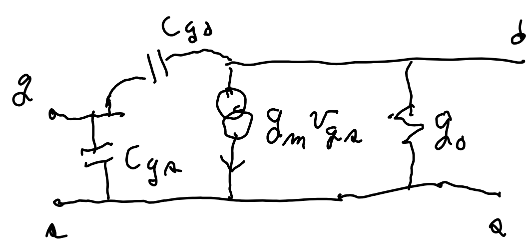
$$\int_{-\infty}^{\infty} v_c(t) e^{st} dt = \mathcal{L}[v_c(t)] = V_c(s)$$

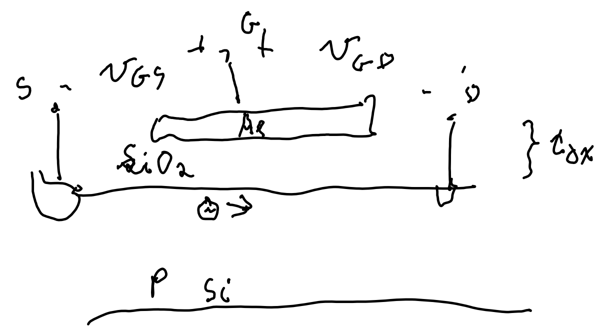
$$e^{j\omega t} = \cos \omega t + j \sin \omega t$$

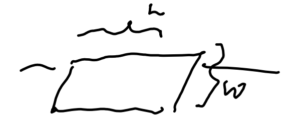
$V_C = \frac{1}{Cs} I_C \Rightarrow$ impedance of C

$\Rightarrow \infty$ as $s \to 0 + j0$

allows signal isolated from bias







$$C_g = \epsilon_{SiO_2} \cdot \frac{L \times W}{t_{ox}}$$