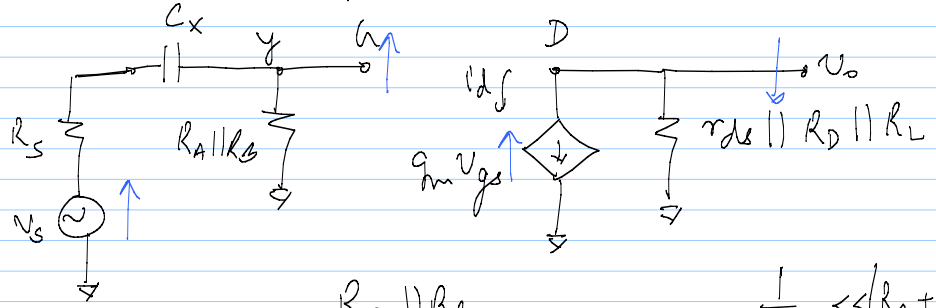
3/9/14

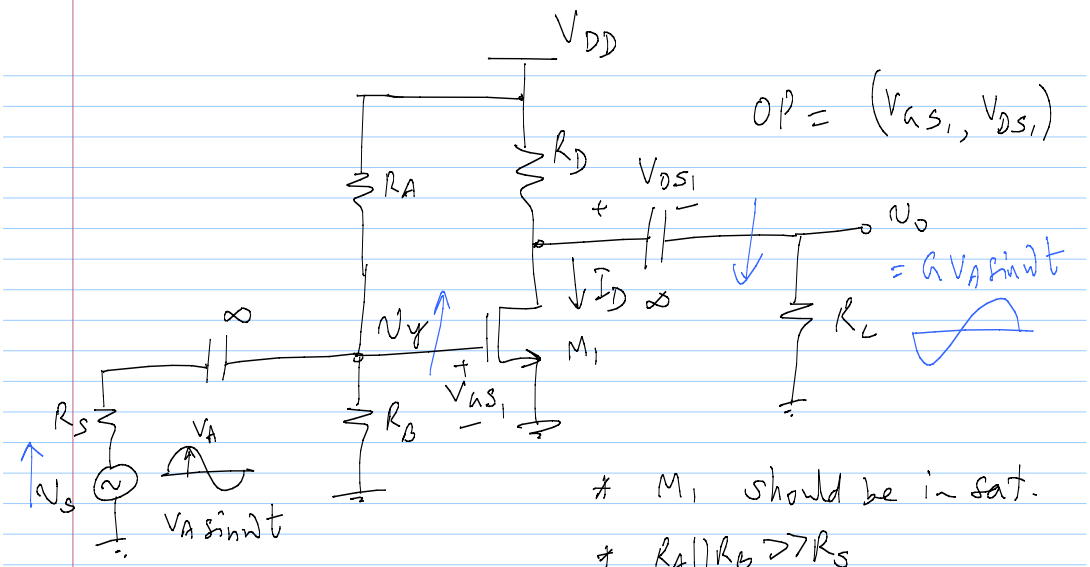
lec 17

Choice of cap:



$$v_y = \underbrace{\frac{R_A \| R_B}{R_A \| R_B + R_S + \frac{1}{j\omega C_x}}}_{a(j\omega) \approx 1} \cdot v_s$$

$\frac{1}{j\omega C_x} \ll (R_S + R_A \| R_B)$



$OP = (V_{GS_1}, V_{DS_1})$

* M_1 should be in sat.
* $R_A \| R_B \gg R_S$
* gain $G = -g_m (R_D \| R_L)$
  $G \gg 1$

For sat:

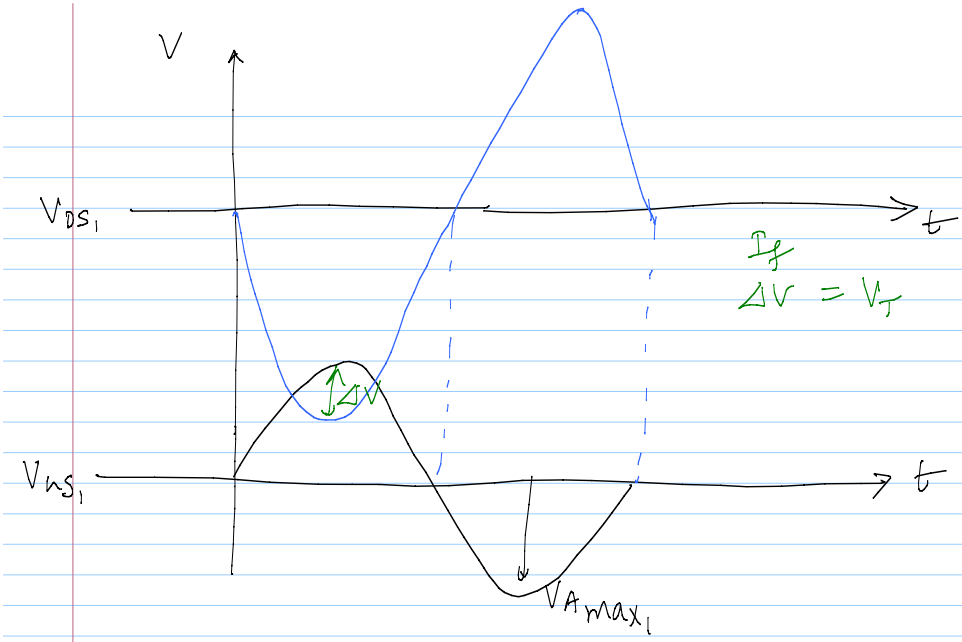
$V_{GS} > V_T$

$V_{DS} > V_{GS} - V_T$

$V_D - V_S > V_G - V_S - V_T$

$V_D > V_G - V_T$

$V_{D_1} > V_{G_1} - V_T$ (DC op)



$V_{A_{max_1}}$ ≡ Maximum value of V_A that keeps M_1 from going into triode region at any time (positive half cycle)

$$V_a = V_{GS_1} + v_s$$

$$V_D = V_{DS_1} - g_m (R_D \| R_L) \cdot v_s$$

@ $V_{A_{max_1}}$, $V_D = V_a - V_T$

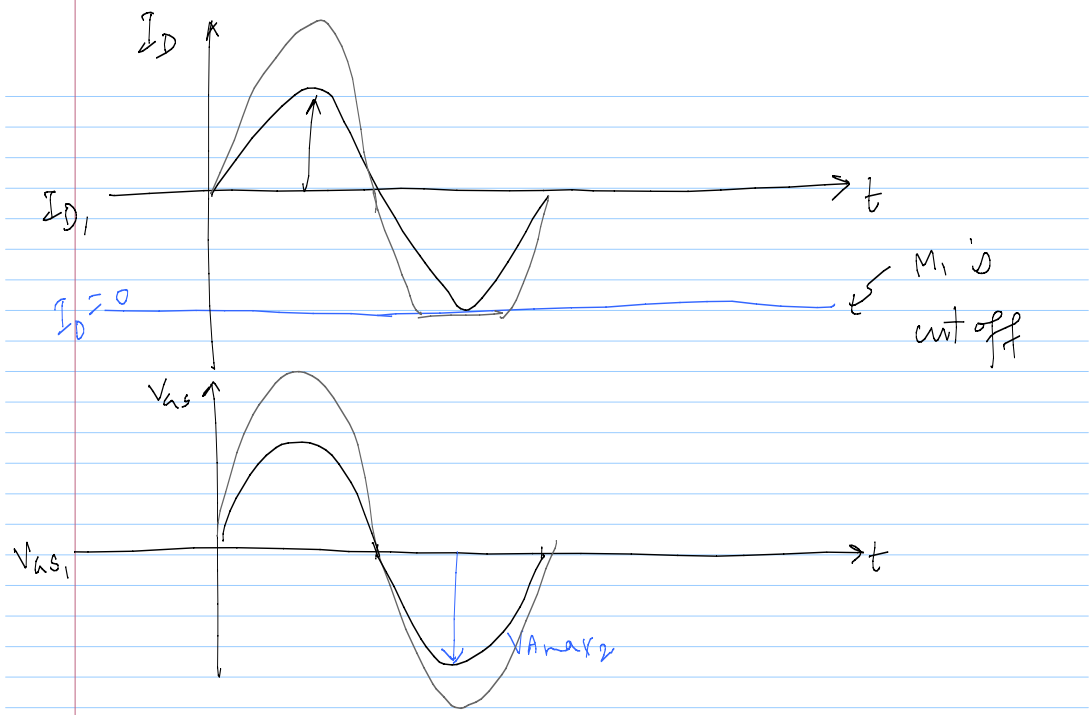
$$\Rightarrow V_{DS_1} - g_m (R_D \| R_L) \cdot V_{A_{max_1}} = V_{GS_1} + V_{A_{max_1}} - V_T$$

$$\boxed{V_{A_{max_1}} = \frac{V_{DS_1} - V_{GS_1} + V_T}{1 + g_m (R_D \| R_L)}}$$

Negative half cycle

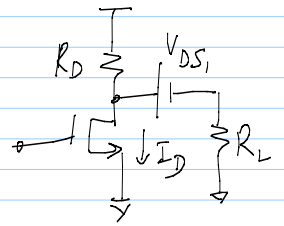
$$I_D = I_{D_1} + g_m v_s$$

I_{D_1}: DC bias; $g_m v_s$: small-signal current (in-phase with v_s)



$I_D = 0$ when $|I_{D_1}| = |g_m V_{A_{max_2}}|$

$$\boxed{V_{A,max_2} = \frac{I_{D_1}}{g_m}}$$



When $I_D = 0$, $V_D = V_{D_0}$

KCL @ Drain: $\frac{V_{DD} - V_{D_0}}{R_D} = \frac{V_{D_0} - V_{DS_1}}{R_L}$

$$\boxed{V_{D_0} = \frac{R_L V_{DD} + R_D V_{DS_1}}{R_D + R_L}}$$