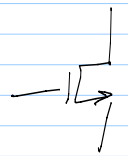
18/9/14

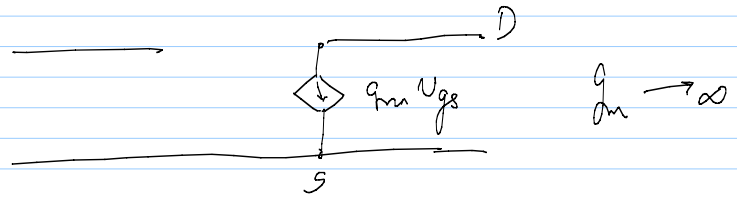
Lec 24

Controlled Sources using MOSFETs (Incremental)

Any g_m



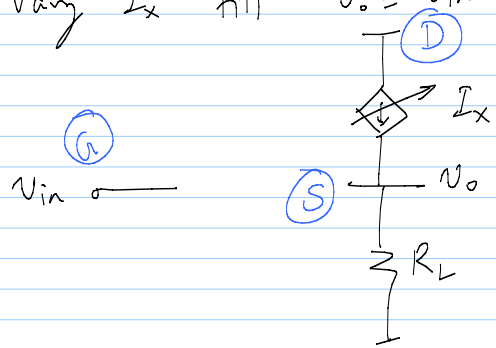
1) VCVS



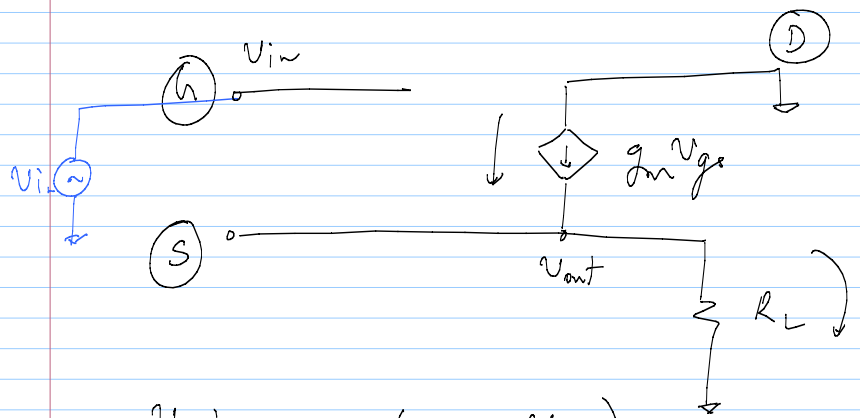
$g_m \to \infty$

VCVS = 1 $\Rightarrow$ $v_{out} = v_{in}$; $Z_{in} = \infty$; $Z_{out} = 0$

* Measure V_{in}, V_{out}
* change V_{out} s.t. $V_{in} = V_{out}$
* vary I_x till $V_o = V_{in}$

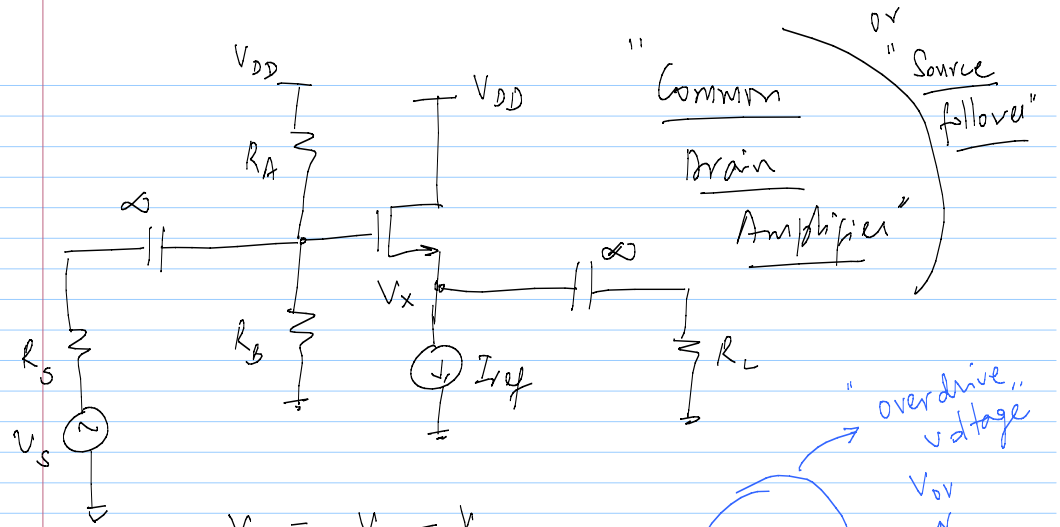


* If $V_{out} > V_{in}$ $\Rightarrow \downarrow I_x$
* If $V_{out} < V_{in}$ $\Rightarrow \uparrow I_x$



$$\frac{V_{out}}{R_L} = g_m (V_{in} - V_{out})$$

$V_{in} \approx V_{out} \Rightarrow g_m \to \infty$

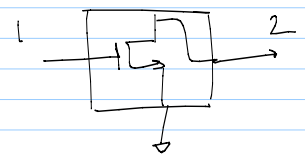


$$V_x = V_a - V_{as}$$

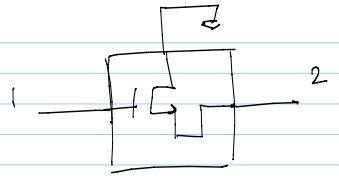
$$= \frac{V_{DD} \cdot R_B}{R_A + R_B} - \left[V_T + \sqrt{\frac{2 I_{ref}}{\mu_n C_{ox} \left(\frac{W}{L}\right)}} \right]$$

"overdrive" voltage

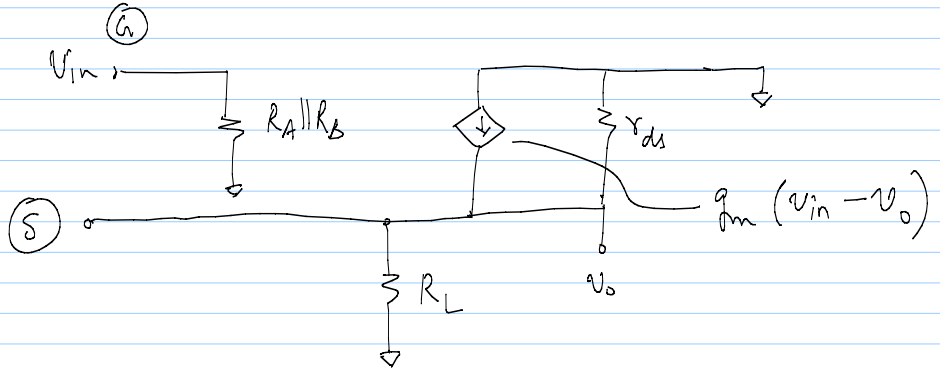
$V_{OV} \approx V_{DSAT}$



C.S.A.

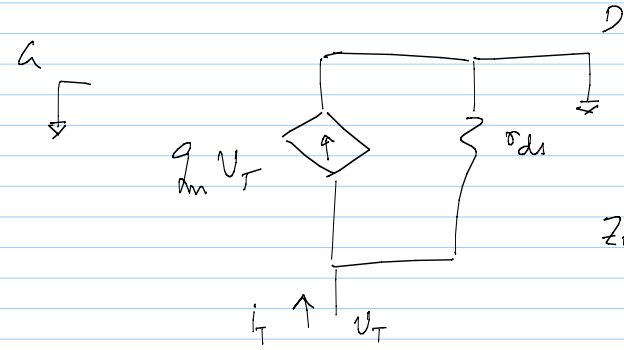


C.D.A.



$Z_{in} = R_A \| R_B \Rightarrow$ choose R_A, R_B = large

$Z_{out} = ?$



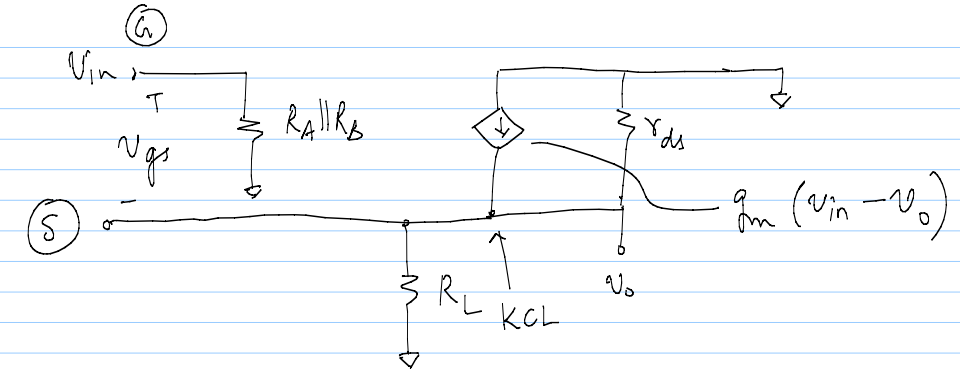
$$Z_{out} = r_{ds} \| 1/g_m$$

$$= \frac{r_{ds}}{1 + g_m r_{ds}}$$

$$= \frac{1}{g_m} \frac{g_m r_{ds}}{1 + g_m r_{ds}}$$

as $g_m \to \infty$ & $r_{ds} \to \infty$

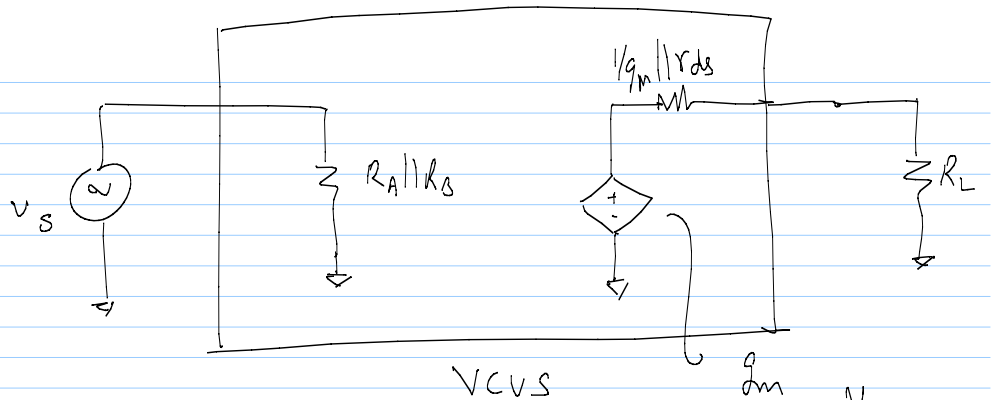
$Z_{out} \to 0$



$$v_{out} [G_L + g_{ds}] = g_m v_{in} - g_m v_{out}$$

$$\frac{v_{out}}{v_{in}} = \frac{g_m}{g_m + g_{ds} + G_L} \quad < 1$$

$= 1$ if $g_m \to \infty$



$$\frac{g_m}{g_m + g_{ds}} v_s$$

* Choose large $R_A \| R_B$
* As $g_m \to \infty$, gain $\to 1$; $Z_{out} \to 0$
* If $r_{ds} = \infty$, $\frac{v_o}{v_s} = \frac{g_m}{g_m + G_L} = \frac{g_m R_L}{1 + g_m R_L}$

$\Rightarrow g_m R_L >> 1$ or $g_m >> \frac{1}{R_L}$