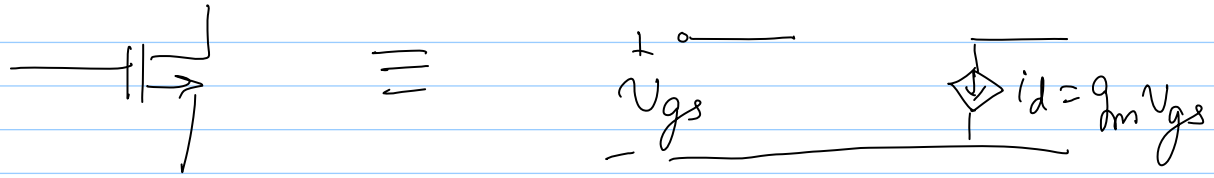
25-9-12

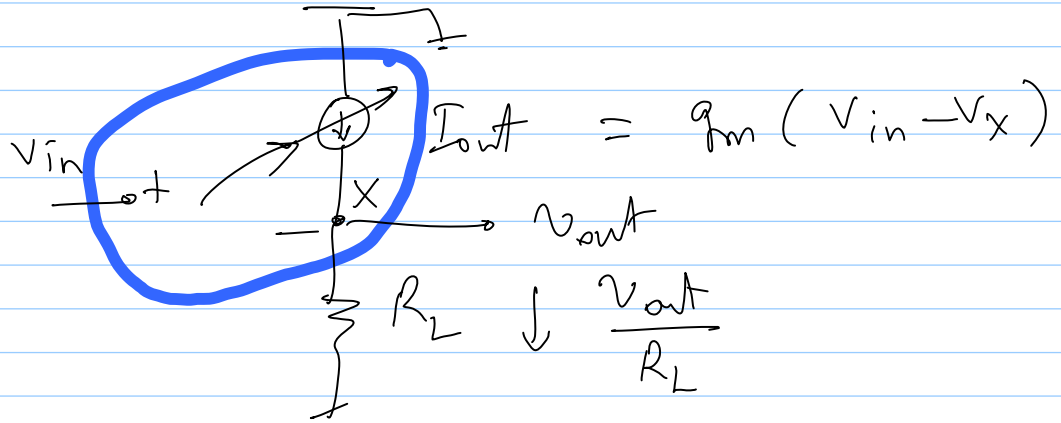
Lec 24

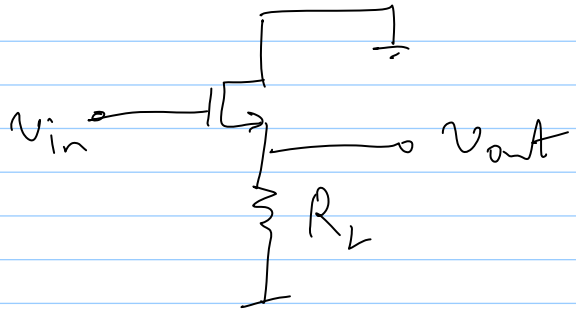


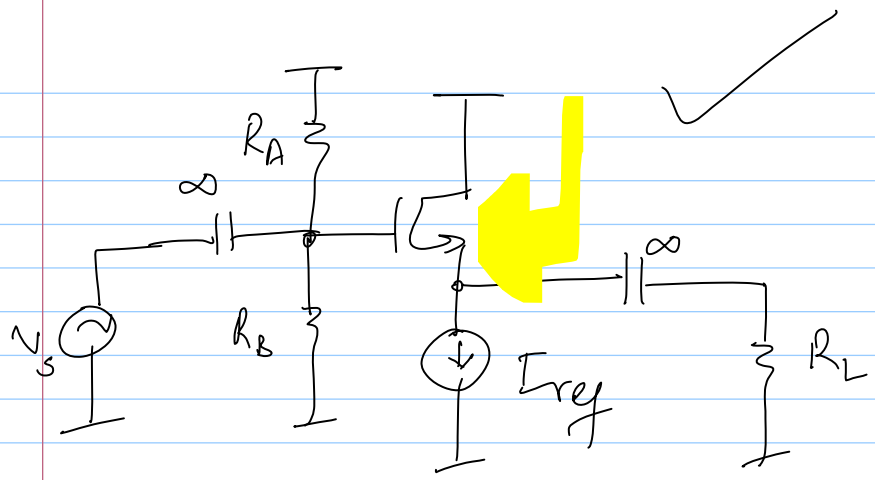
$g_m \to \infty$

VCVS $\quad Z_{in} = \infty, \quad Z_{out} = 0$

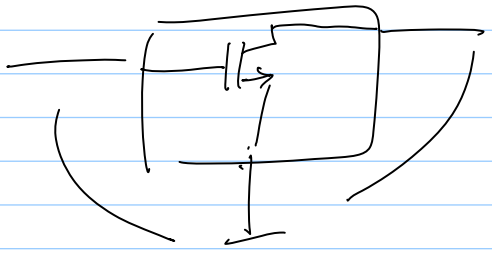
$v_{in} = v_{out}$



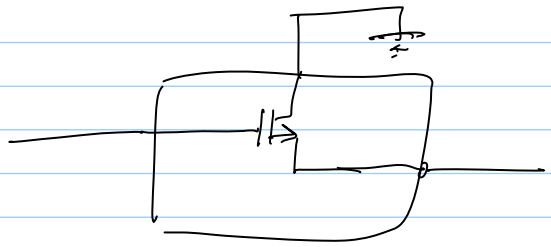




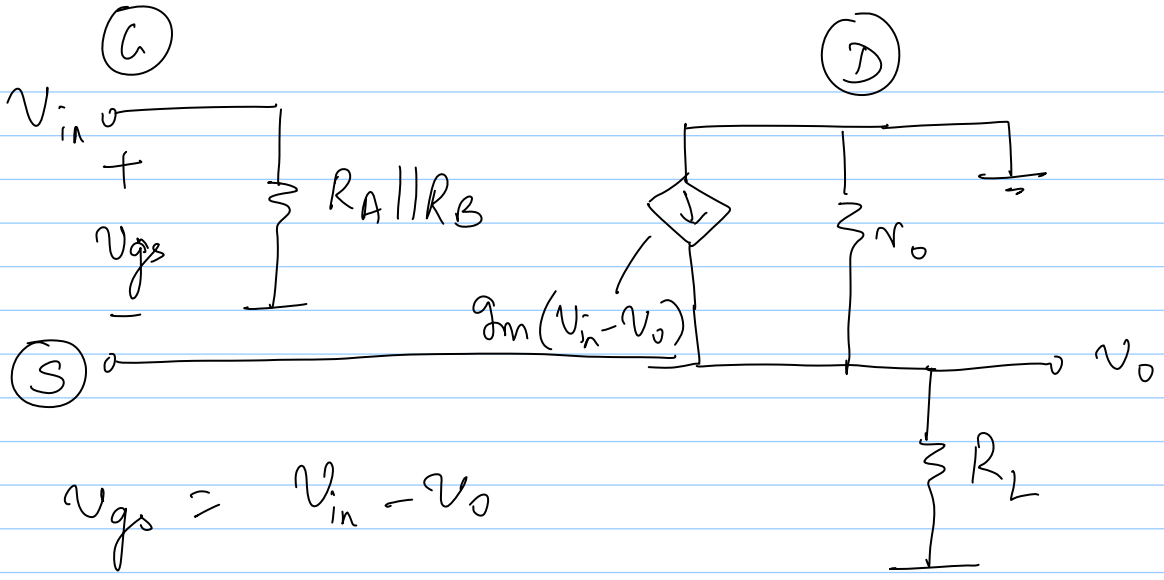
Common Drain Amplifier



C.S.A.



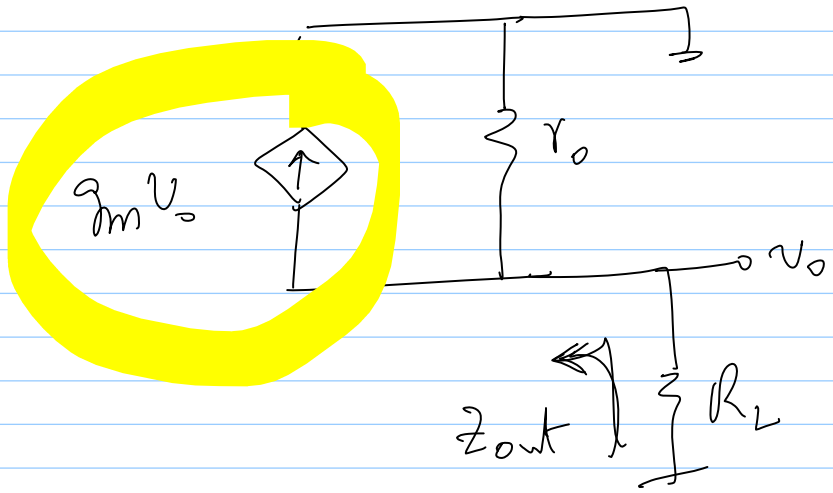
C.D.A.



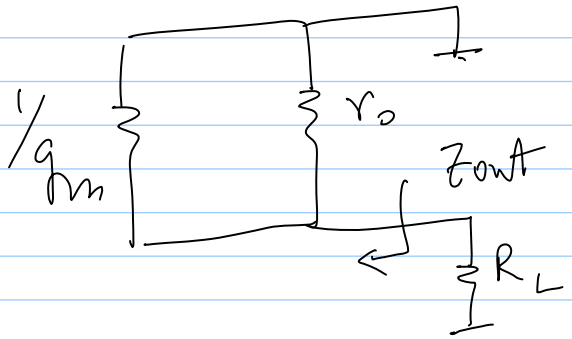
$$V_{gs} = V_{in} - V_o$$

$$Z_{in} = R_A \| R_B \quad \text{(can be very large)}$$

$$Z_{out} = ?$$



$$\equiv$$

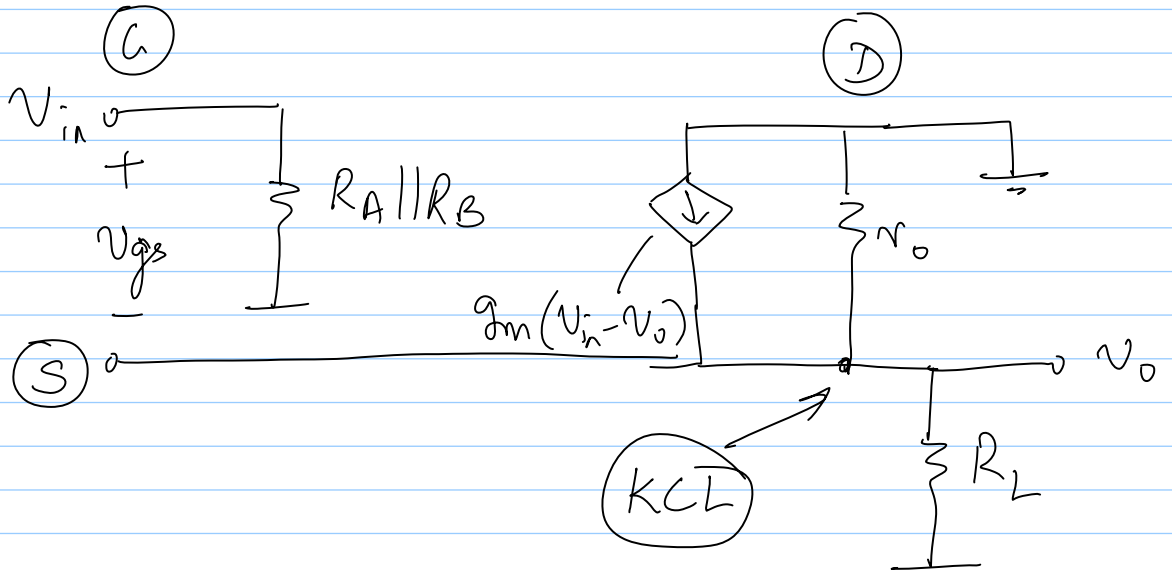


$$Z_{out} = r_o \,||\, 1/g_m$$

$$= \frac{r_o}{1 + g_m r_o}$$

$$= \frac{1}{g_m} \cdot \frac{g_m r_o}{1 + g_m r_o}$$

If $g_m r_o \gg 1 \Rightarrow Z_{out} = 1/g_m$



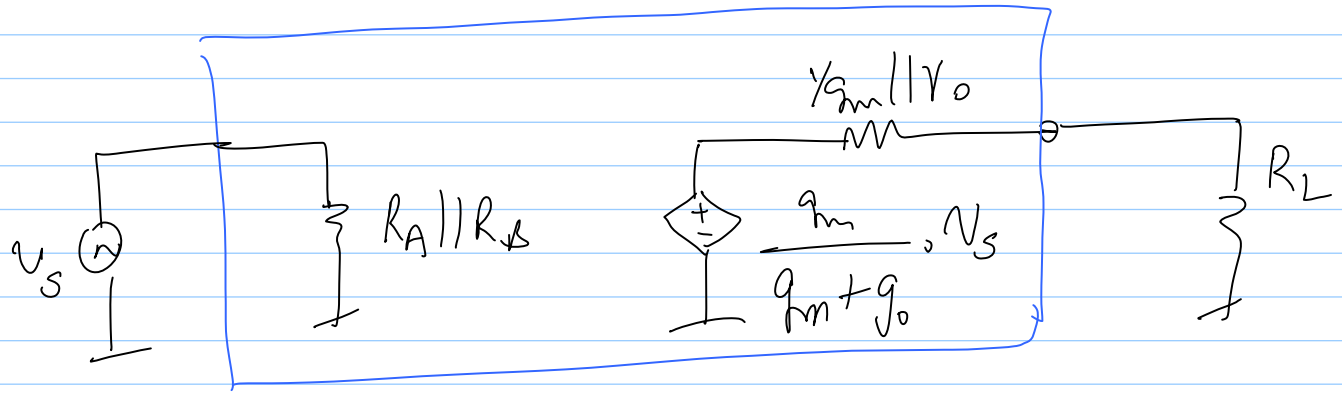
$$v_{out}(G_L + g_o) = g_m v_{in} - g_m v_{out}$$

$$v_{out}(G_L + g_o + g_m) = g_m v_{in}$$

$$\frac{v_{out}}{v_{in}} = \frac{g_m}{g_m + G_L + g_o}$$

* $\frac{v_{out}}{v_{in}} < 1$ SOURCE FOLLOWER

$= 1 \quad g_m \to \infty$



* Choose large $R_A // R_B$
* as $g_m \to \infty$, gain $\to 1$
  $Z_{out} \to 0$
* If $r_o = \infty$, $\frac{v_{out}}{v_s} = \frac{g_m}{g_m + G_L}$

$$\frac{v_{out}}{v_s} = \frac{g_m R_L}{1 + g_m R_L} \to 1 \text{ when } g_m R_L >> 1$$

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

Swing limits of Common Drain Amp

$v_s = V_A \sin \omega t$

as $V_A \uparrow \Rightarrow$ * $g_m \to \infty$ may not be valid

* clipping → cutoff
  → triode

Cutoff ($V_{A,1}$)

$I_D = I_Q + i_d$

I_Q / I_{reg}

i_d

neglect g_o

$$i_d = \frac{v_{out}}{R_L} = \frac{1}{R_L} \cdot \frac{g_m R_L}{1 + g_m R_L} \cdot v_s$$

$$I_D = I_{reg} + \frac{g_m R_L}{1 + g_m R_L} \cdot \frac{V_{A,1} \sin \omega t}{R_L}$$

$$I_D = 0 \Rightarrow V_{A,1} = I_{reg} R_L \left(1 + \frac{1}{g_m R_L}\right)$$

triode limit (V_{A_2})

$$V_D = V_G - V_T$$

$$V_{DD} = \frac{V_{DD} \cdot R_B}{R_A + R_B} + V_{A_2} \sin \omega t - V_T$$

$$V_{A_2} = \frac{V_{DD} \cdot R_A}{R_A + R_B} + V_T$$

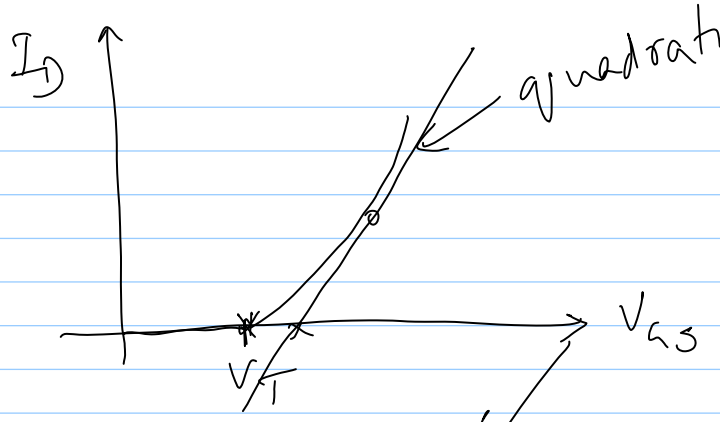
$$V_{A_{max}} = \min \cdot \{ V_{A_1}, V_{A_2} \}$$

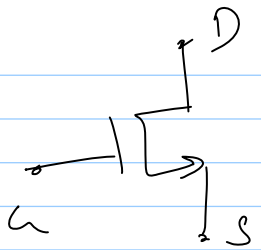
$$g_m R_L = 10$$

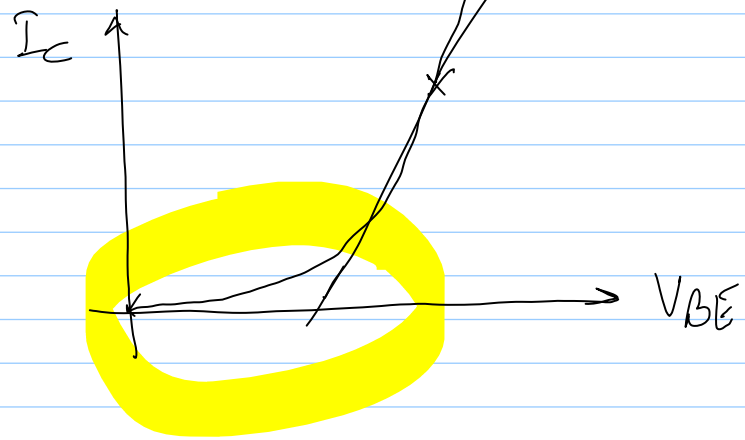
1) $R_L = 1k\Omega \Rightarrow g_m = 10mS$

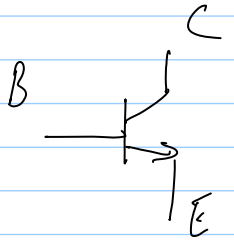
2) $R_L = 10k\Omega \Rightarrow g_m = 1mS$

3) $R_L = 100\Omega \Rightarrow g_m = 100mS$



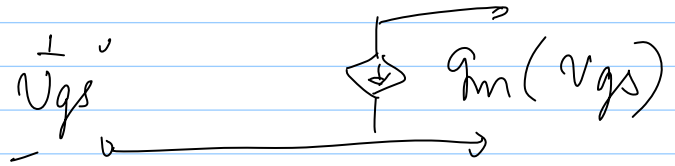




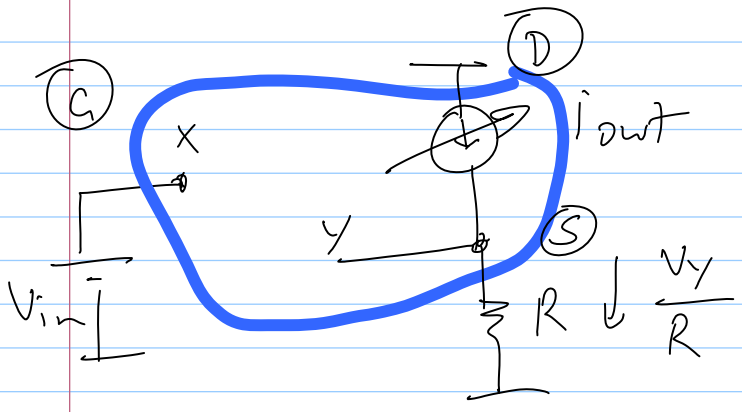


VCCS (incremental) using a MOSFET

$i_{out} = \frac{v_{in}}{R}$



$g_m \to \infty$



$V_x > V_y \Rightarrow i_{out}$ is too low $\Rightarrow \uparrow i_{out}$

$V_x < V_y \Rightarrow i_{out}$ is too large $\Rightarrow \downarrow i_{out}$

$i_{out} \propto (V_x - V_y) \Rightarrow i_{out} = g_m(V_x - V_y)$

as $g_m \to \infty$, $V_x = V_y$

or $i_{out} = \overleftarrow{\frac{V_{in}}{R}}$