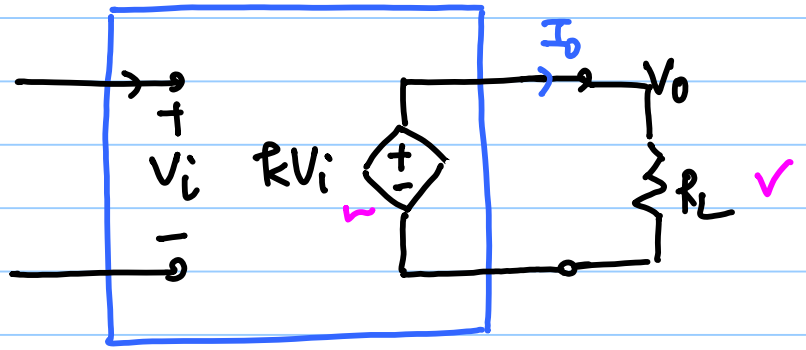
lecture # 21

Note Title 21-09-2021

- Voltage controlled current source (VCCS)

- Voltage controlled voltage source (VCVS)

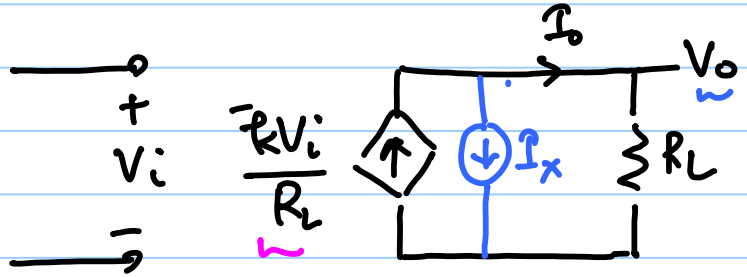
Ideal



$Z_i = \infty$, $Z_o = 0$

$$I_o = \frac{V_o}{R_L} = \frac{kV_i}{R_L}$$

R_{L1}, R_{L2} } $V_o = kV_i$



$$V_o = \frac{kV_i}{R_L} \cdot R_L = kV_i$$

if $V_o > kV_i$ then $I_x = g(V_o - kV_i)$

$V_o < kV_i$ then $I_x = -g(V_o - kV_i)$

$$\left(\frac{kV_i}{R_L} - I_x\right) R_L = V_o$$

$$\left\{ \frac{kV_i}{R_L} - g(V_o - kV_i) \right\} R_L = V_o$$

$$\left\{ kV_i \left(\frac{1}{R_L} + g \right) - gV_o \right\} R_L = V_o$$

if $k=1$

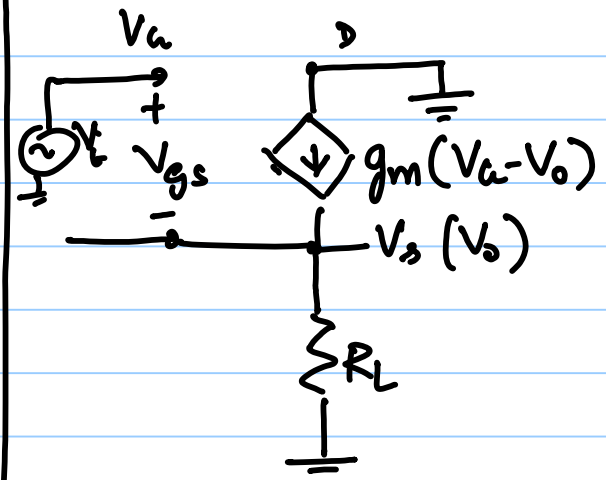
$$\left\{ V_i \left(\frac{1}{R_L} + g \right) - gV_o \right\} R_L = V_o$$

g is very large

$$g(V_i - V_o) \cdot R_L = V_o$$

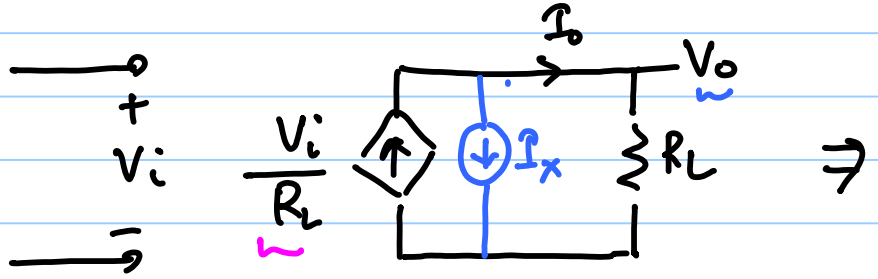
$$V_o = \frac{gR_L}{1+gR_L} V_i$$

$$\approx V_i$$

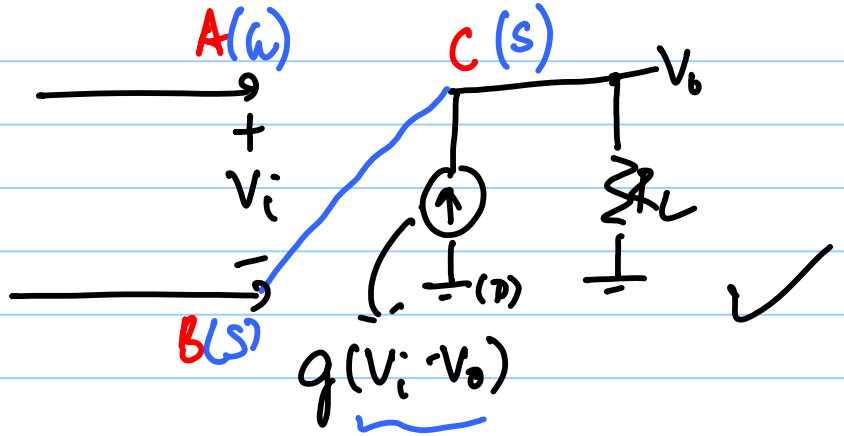


$$g_m(V_i - V_o) = \frac{V_o}{R_L}$$

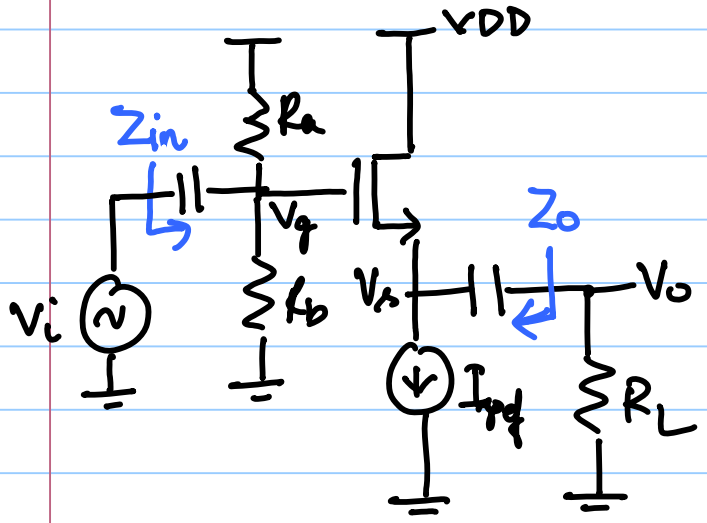
$$V_o = \frac{g_m R_L}{1+g_m R_L} V_i$$



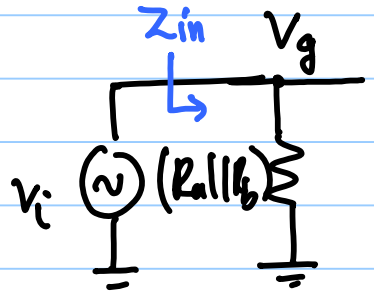
⇒

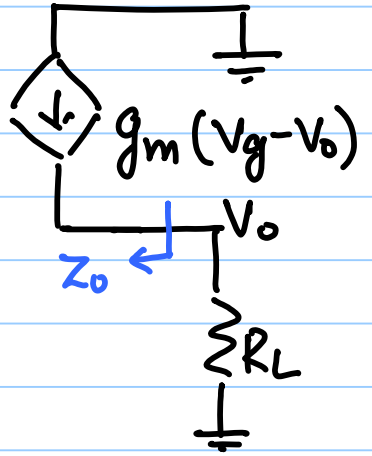


✓



VCVS

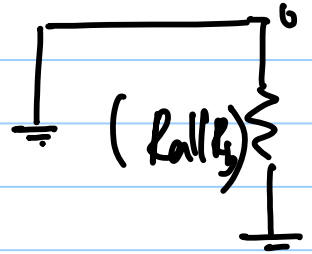


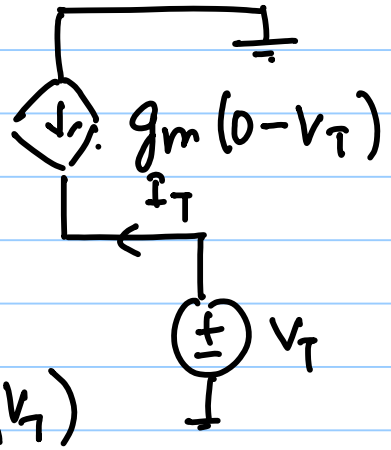


- $Z_{in} = (R_a \| R_b)$ ✓

- $Z_o = \frac{1}{g_m} \xrightarrow{g_m \to \infty} Z_o = 0$

- $\frac{V_o}{V_i} \approx 1$



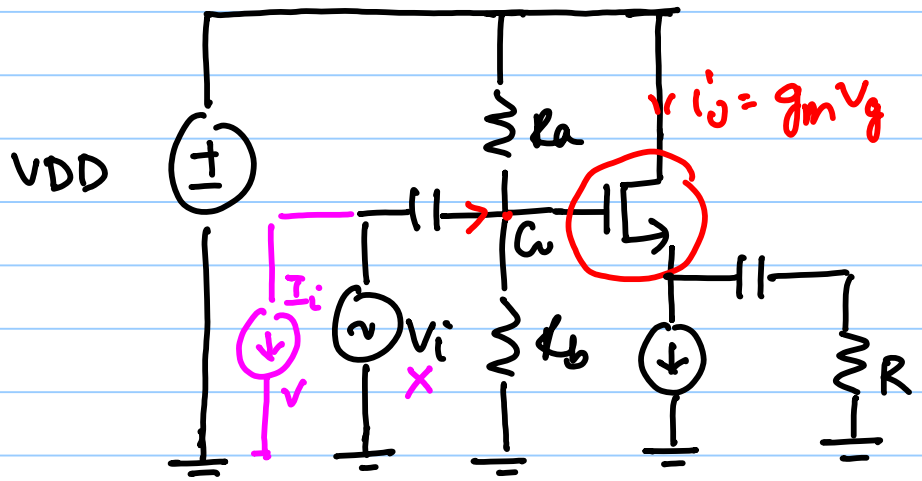


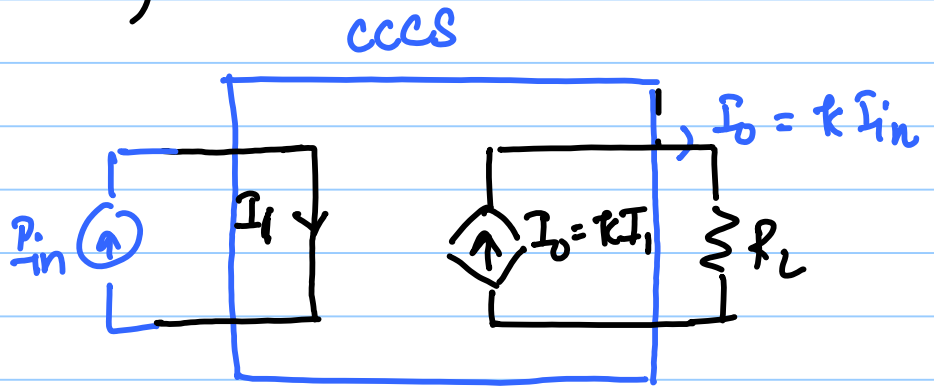
$$I_T = -(-g_m V_T)$$

$$= g_m V_T$$

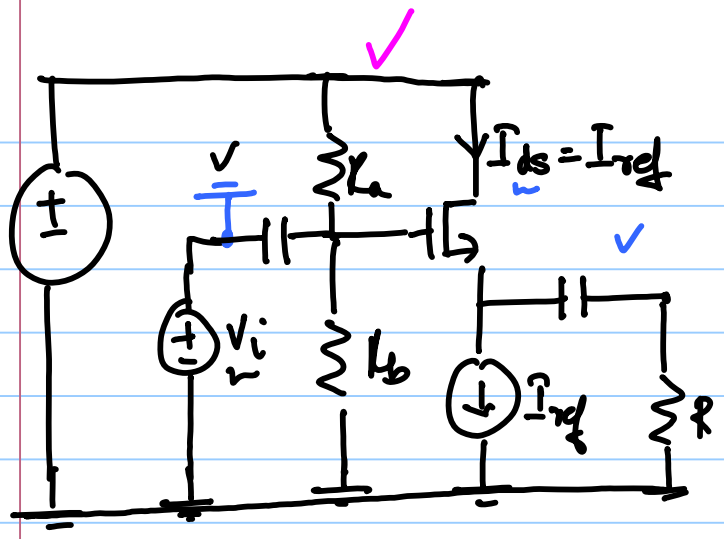
$$Z_o = V_T / I_T = 1/g_m$$

Current Controlled Current Source (CCCS)

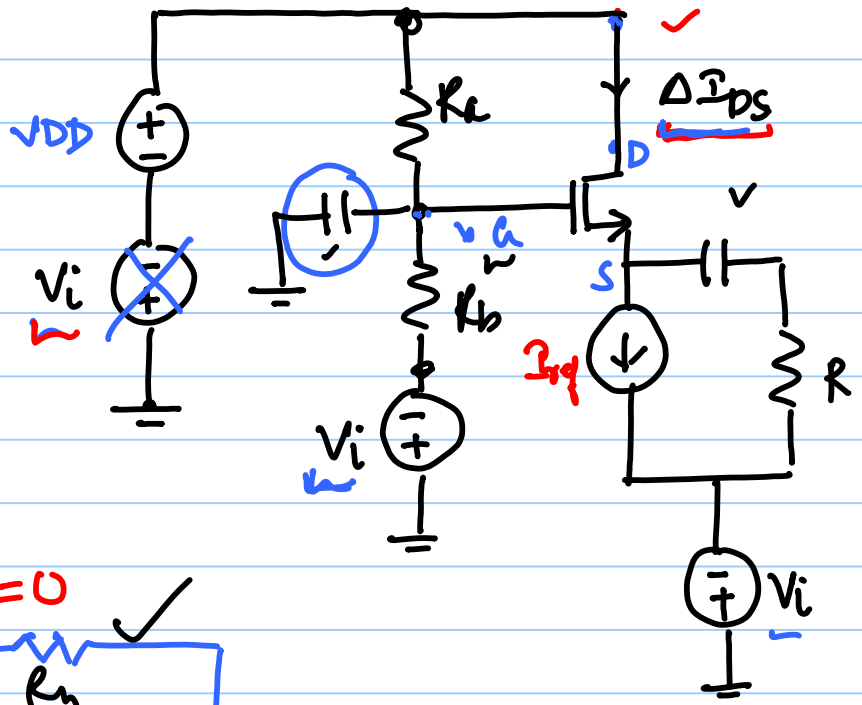




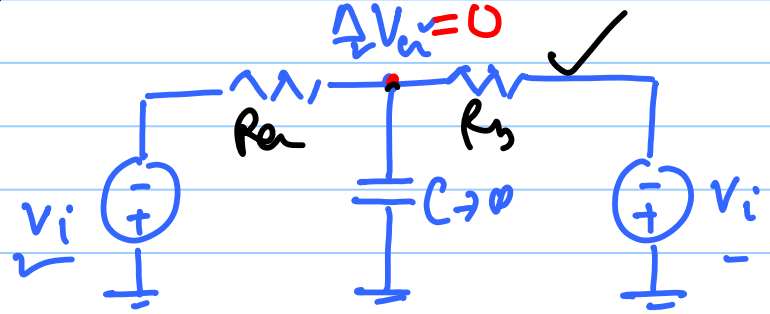
$$V_g = -I_i (R_a \| R_b)$$

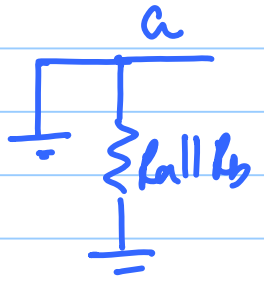


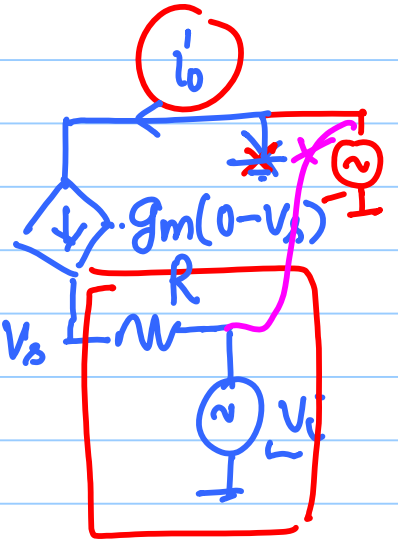
Analysis ✓



$$\Delta I_{DS} = f(V_i)$$







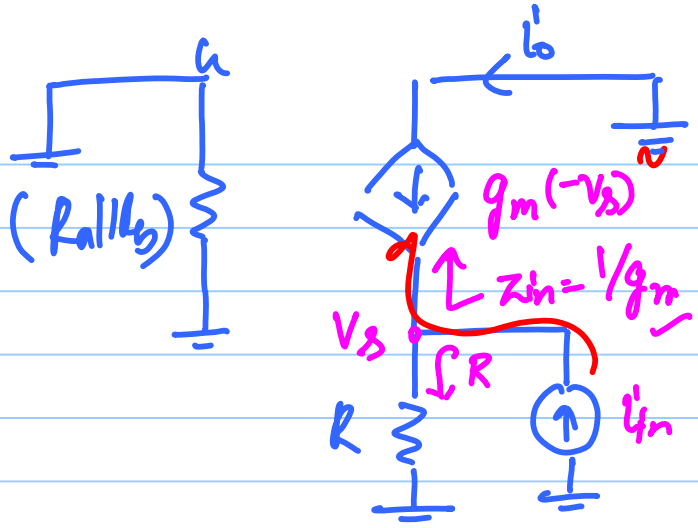
$$i_o = -g_m V_s = \frac{V_s - V_i}{R}$$

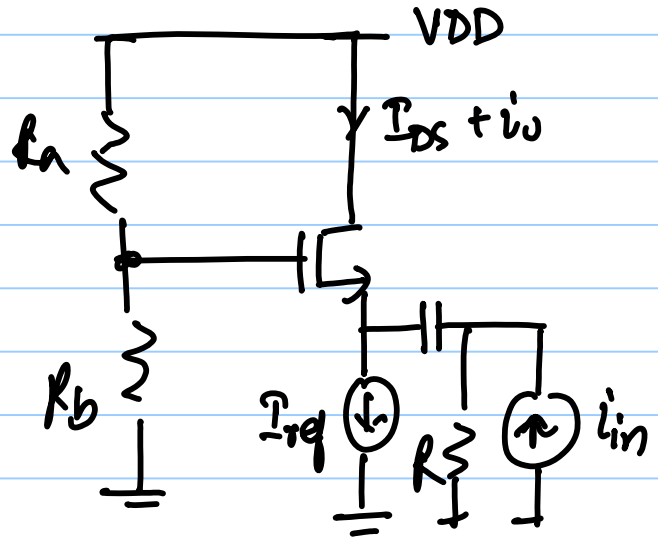
$$\Rightarrow \quad V_s = \frac{1}{1+g_m R} V_i \xrightarrow{g_m R \to \infty} V_s = 0$$

$$i_o = -\frac{g_m}{1+g_m R} V_i \xrightarrow{g_m R \to \infty} i_o = -\frac{V_i}{R}.$$

$$i_o = -\frac{g_m}{1+g_m R} v_i \longrightarrow i_o = -\frac{v_i}{R}$$

$$i_o = -i_{in}$$





$$i_o = i_{in} \frac{R}{R + \frac{1}{g_m}}$$

Common-Gate Amplifier (CG)