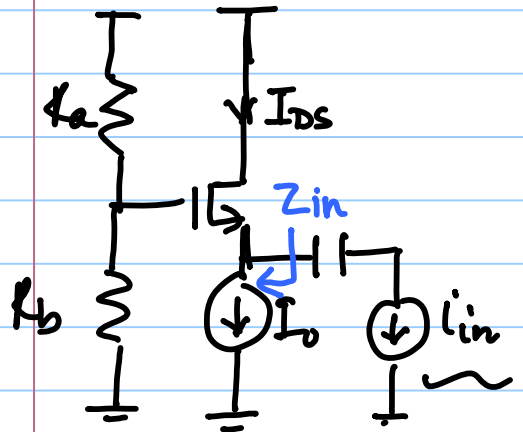
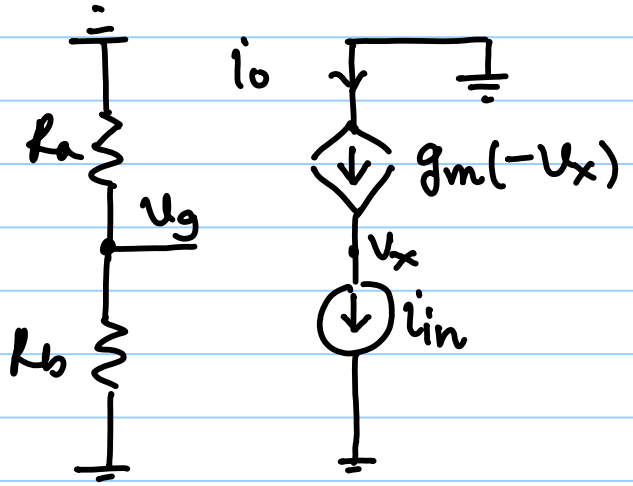
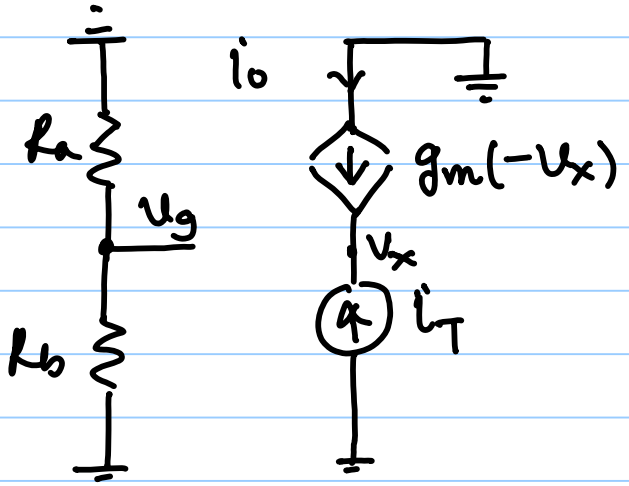
Lecture # 22

Note Title 22-09-2021

CCCS







Common-Gate Amp.

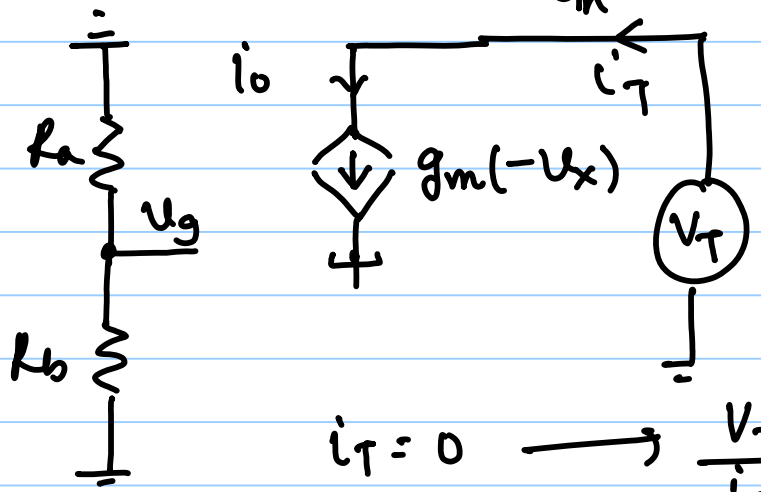
$$i_o = -g_m v_x = i_{in}$$

$$i_T = +g_m v_x$$

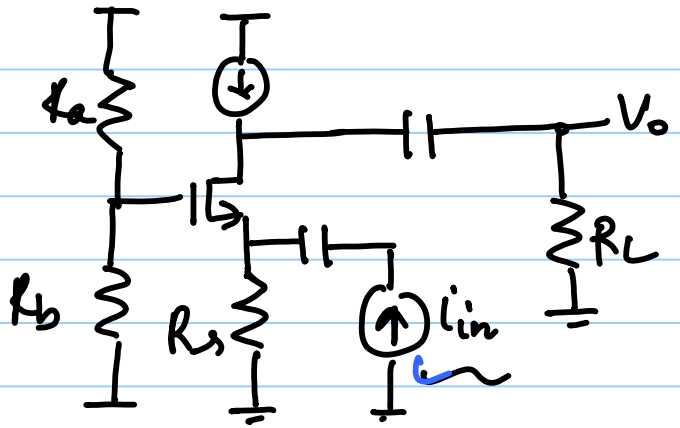
$$\frac{i_o}{i_{in}} = 1$$

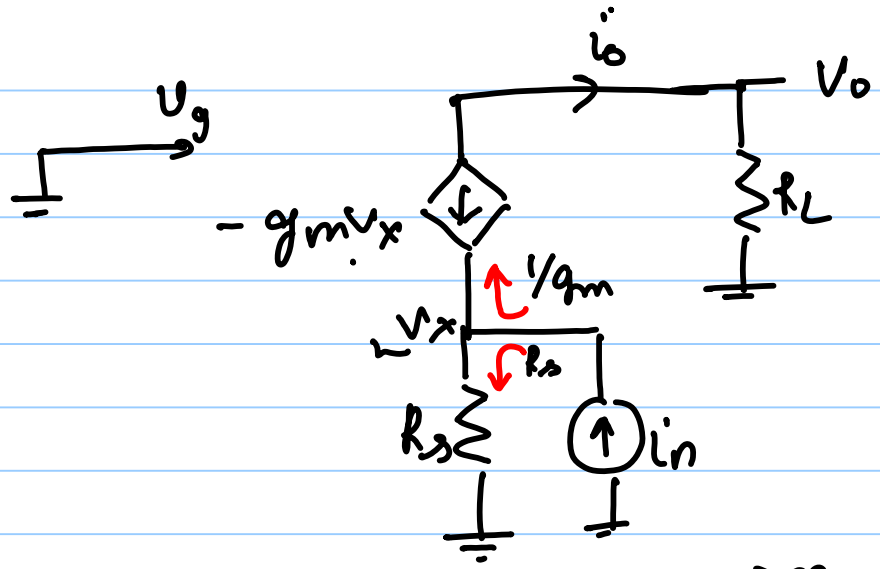
$$Z_{in} = \frac{v_x}{i_T} = +\frac{1}{g_m}$$

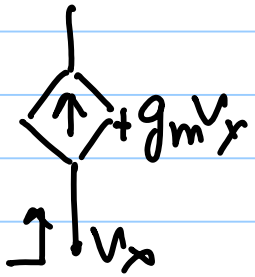
$$Z_{in} \xrightarrow{g_m \to \infty} 0$$



$$i_T = 0 \longrightarrow \frac{V_T}{i_T} = \infty$$



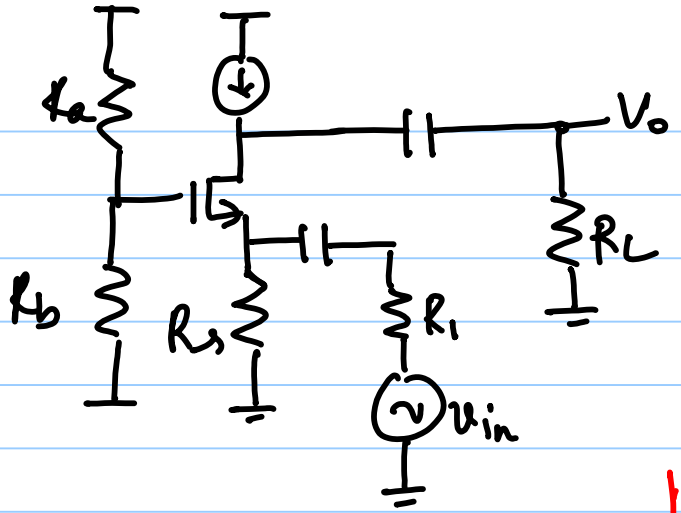


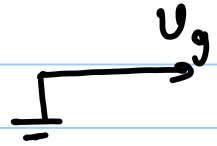


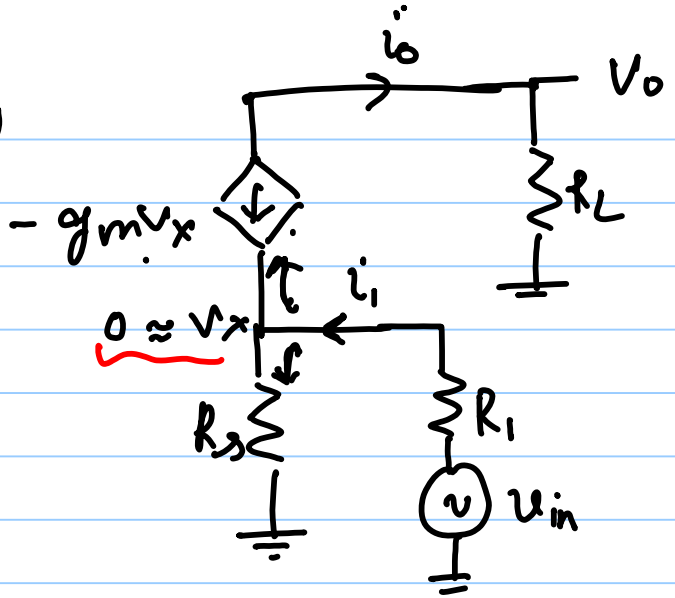
$$Z = \frac{1}{g_m}$$

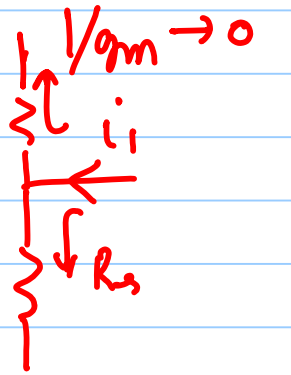
$$i_o = \left(\frac{R}{\frac{1}{g_m} + R}\right) i_{in} \xrightarrow{g_m \to \infty} i_o = i_{in}$$

$$V_o = \frac{g_m R}{1 + g_m R} i_{in} R_L \xrightarrow{g_m \to \infty} i_{in} \cdot R_L$$









$$v_{out} = \frac{R_s}{R_s + \frac{1}{g_m}} \times i_1$$

$$i_1 = \frac{v_{in}}{R_1}$$

$$i_o' = i_1$$

$$v_o = v_{in} \cdot \frac{R_L}{R_1}$$

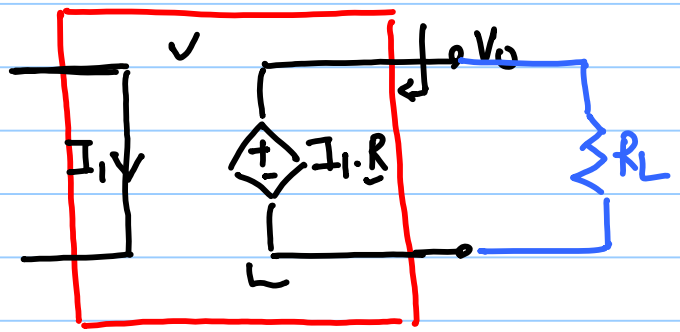
$$\frac{v_o}{v_{in}} = \frac{R_L}{R_1}$$

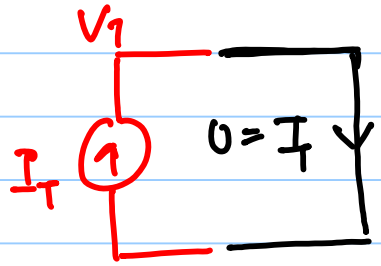
$g_m \to \infty$

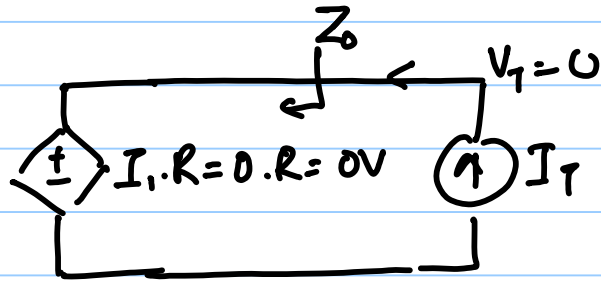
$$v_x = v_{in} \times \frac{\frac{1}{g_m} \| R_s}{\left(\frac{1}{g_m} \| R_s\right) + R_1}$$

$$v_o = g_m v_x \cdot R_L$$

Current Controlled Voltage Sources (CCVS)

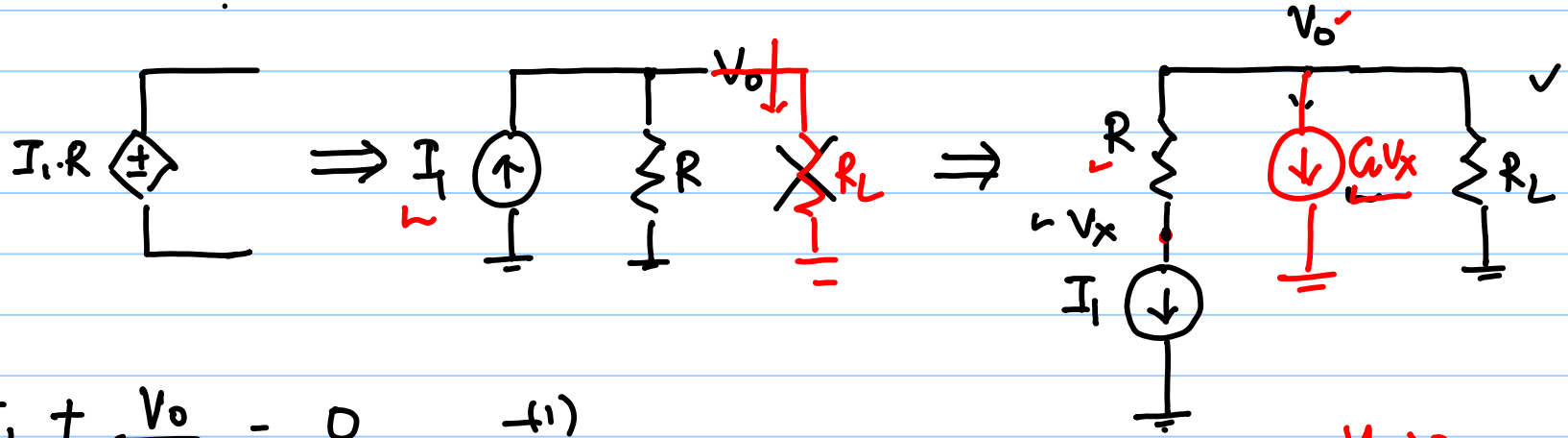






$$Z_o = \frac{V_T}{I_T} = \frac{0}{I_T} = 0\Omega$$

$Z_{in} = 0$, $Z_o = 0$



$$GV_x + I_1 + \frac{V_o}{R_L} = 0 \quad -(1)$$

$$V_o = V_x + I_1.R \quad -(2)$$

$$V_o = V_x + I_1.R \xrightarrow{V_x \to 0} V_o = I_1.R$$

$V_x > 0$

$V_x < 0$

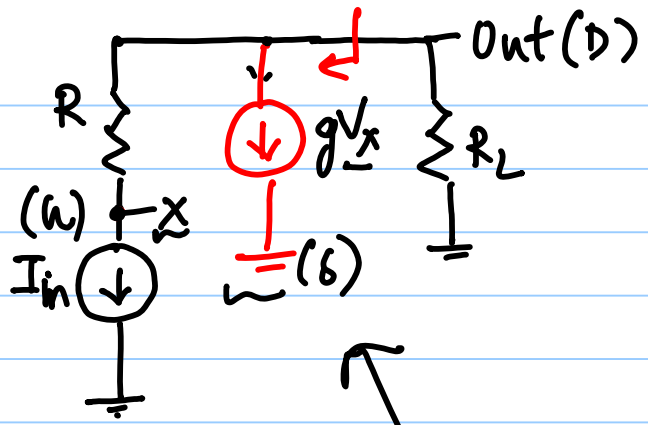
$$A\left(V_0 - I_1 \cdot R\right) + I_1 + \frac{V_0}{R_L} = 0$$

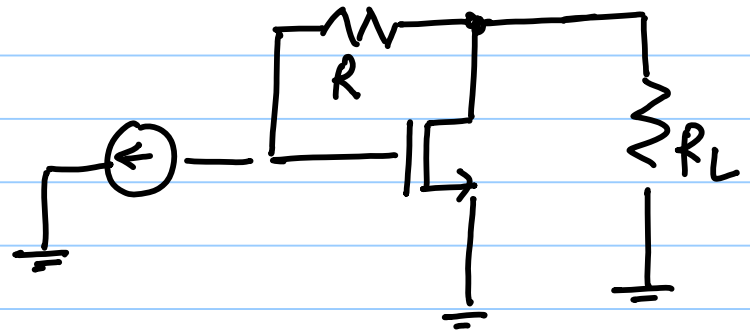
$$V_0\left(A + \frac{1}{R_L}\right) = I_1 \cdot R \cdot A - I_1 = I_1 R\left(A - \frac{1}{R}\right)$$

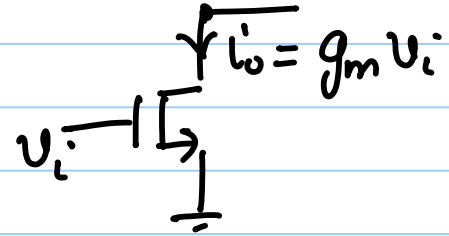
$$V_0 = I_1 \cdot R \frac{\left(A - \frac{1}{R}\right)}{\left(A + \frac{1}{R_L}\right)} \xrightarrow{A \to \infty} V_0 = I_1 \cdot R$$

$$V_x = V_0 - I_1 \cdot R = I_1 \cdot R \frac{\left(\cancel{A} - \frac{1}{R} - \cancel{A} - \frac{1}{R_L}\right)}{A + \frac{1}{R_L}}$$

$$= I_1 \cdot R \frac{\left(-\frac{1}{R} - \frac{1}{R_L}\right)}{\left(A + \frac{1}{R_L}\right)} \xrightarrow{A \to \infty} V_x = 0$$

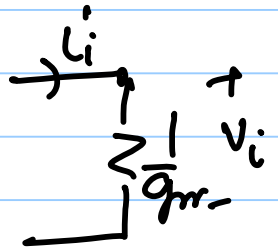


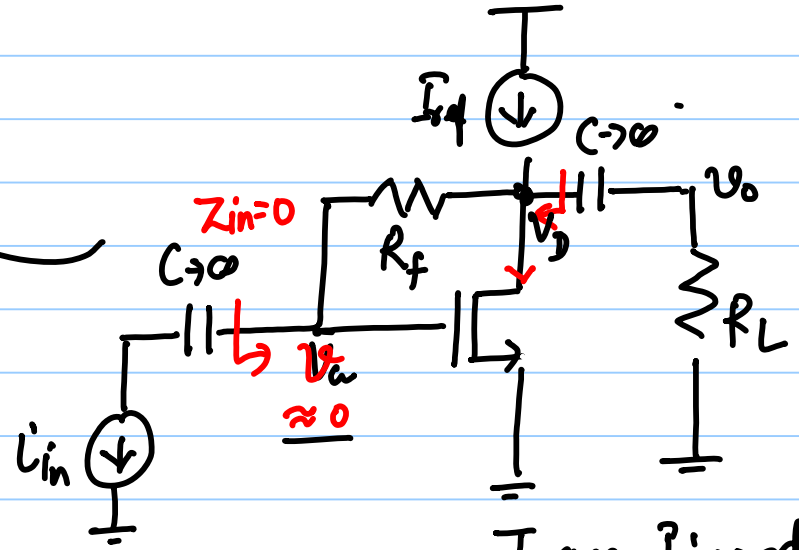




$$\frac{i_o}{v_i} = g_m$$

Trans-Conductance

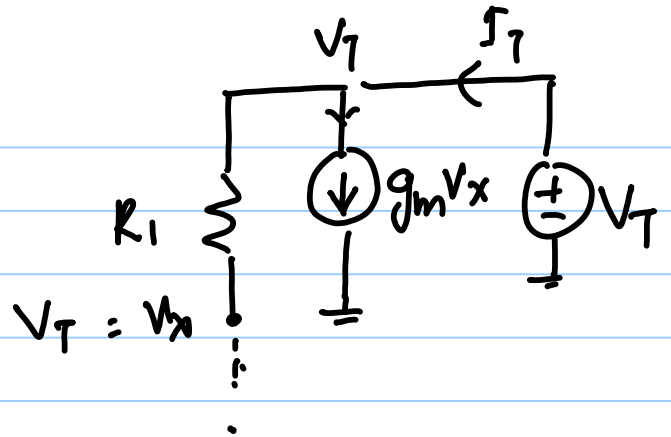




Trans-Impedance Amp.

$$v_o = i_{in} \cdot R_f \qquad \text{(TIA)}.$$

$$\frac{v_o}{i_{in}} = R_f$$



$$I_T = g_m V_T$$

$$\frac{V_T}{I_T} = \frac{1}{g_m} \to 0$$

- Common Source (CS) Amp.
- Common Drain (CD) Amp.
- Common Gate (CG) Amp.

- VCCS
- VCVS
- CCCS
- CCVS

- Transimpedance Amp.