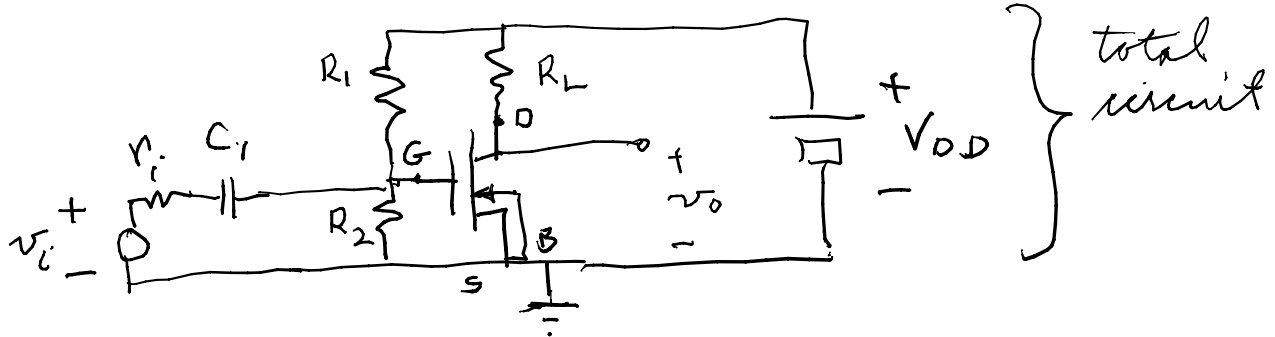


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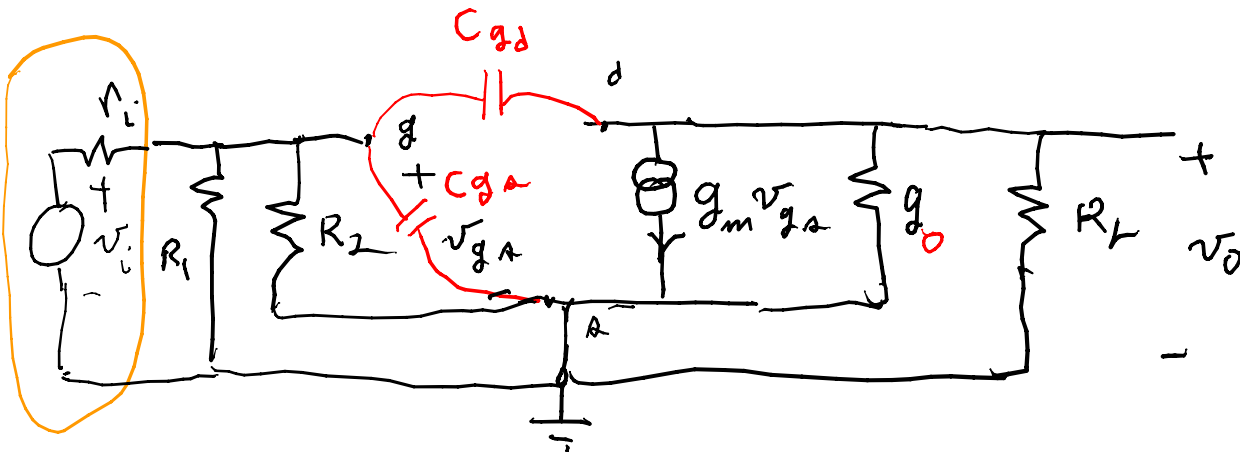
Small signal amplification



C_i very large $Z_{C_i} = \frac{1}{j\omega C_i} \Rightarrow \left| \frac{1}{j\omega C_i} \right| \Rightarrow \frac{1}{\omega C_i}$ small at the lowest frequency we use

$C_i \rightarrow$ large

small signal $\rightarrow$ shift origin to bias point

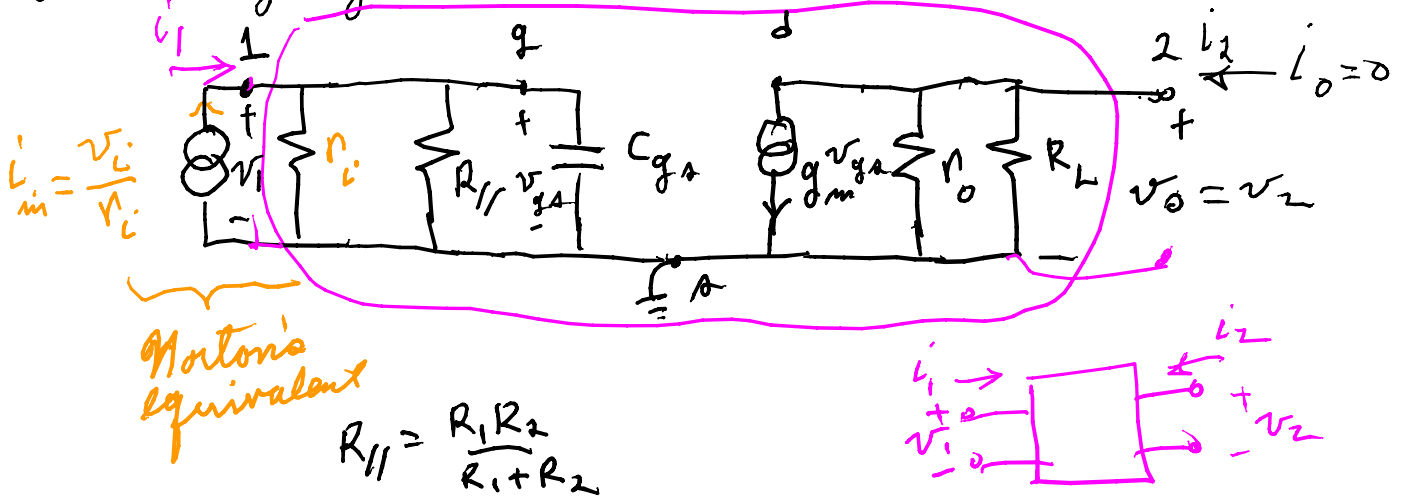


P. 321 $C_{gs} = \frac{2}{3} W L C_{ox}$, $C_{gd} \approx 0$ in saturation
Eq. (4.108) Eq. (4.109)

can find $\frac{v_o}{v_i}(s) = \frac{k_1}{s + d_1}$ if $C_{gd} = 0$

if $C_{gs} \neq 0$ $\frac{v_o}{v_i} = \frac{M_{12} + M_{21}}{s^2 + \omega_0 s + \omega_0^2}$

The transfer function when $C_{gs} = 0$



$$\mathbf{I} = \mathbf{YV} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} v_{gs} \\ v_{ds} \end{bmatrix} = \begin{bmatrix} i_{in} \\ 0 \end{bmatrix}$$

$v_{ds} = v_o$

$$Y_{21} v_{gs} + Y_{22} v_o = 0 \Rightarrow v_o = -\frac{Y_{21} v_{gs}}{Y_{22}}$$

but $Y_{11} v_{gs} + Y_{12} v_o = i_{in}$

$$v_{gs} = \frac{i_{in} - Y_{12} v_o}{Y_{11}} \Rightarrow v_o = -\left(\frac{Y_{21}}{Y_{12}}\right) \left[\frac{i_{in} - Y_{12} v_o}{Y_{11}} \right]$$

$$(Y_{11} Y_{22} - Y_{12} Y_{21}) v_o = -Y_{21} i_{in}$$

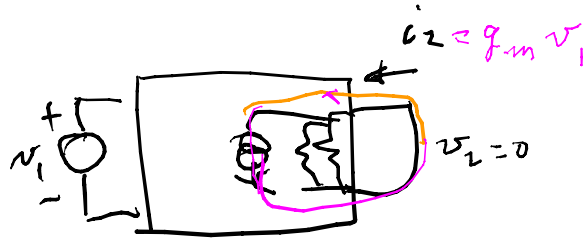
$$\frac{v_o}{i_{in}} = \frac{-Y_{21}}{\det \mathbf{Y}} = \frac{v_o}{v_i / r_i}$$

$$T(s) = \frac{v_o}{v_i} = v_i \left(\frac{-Y_{21}}{\det Y} \right)$$

$$\therefore \text{want } Y(s); \quad Y_{11} = \left. \frac{i_1}{v_1} \right|_{v_2=0} = (g_i + G_{11}) + sC_{gs}$$

$$Y_{12} = \left. \frac{i_1}{v_2} \right|_{v_1=0} = 0$$

$$Y_{21} = \left. \frac{i_2}{v_1} \right|_{v_2=0} = g_m$$



$$Y_{22} = \left. \frac{i_2}{v_2} \right|_{v_1=0} = g_o + G_L$$

$$Y_{11} Y_{22} = \det = ((g_i + G_{11}) + sC_{gs})(g_o + G_L)$$

$$-Y_{21} = -g_m$$

$$\frac{v_o}{v_i}(s) = \frac{-g_m}{(g_o + G_L)(sC_{gs} + (g_i + G_{11}))}$$