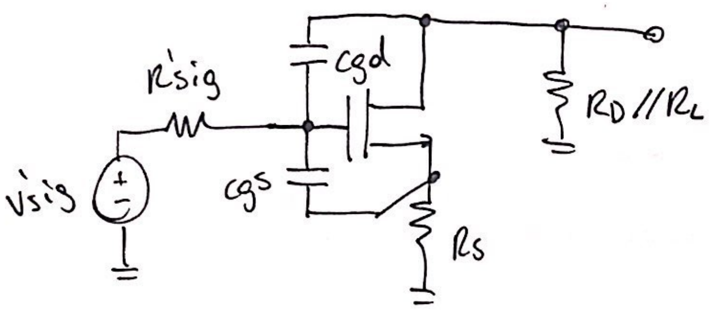
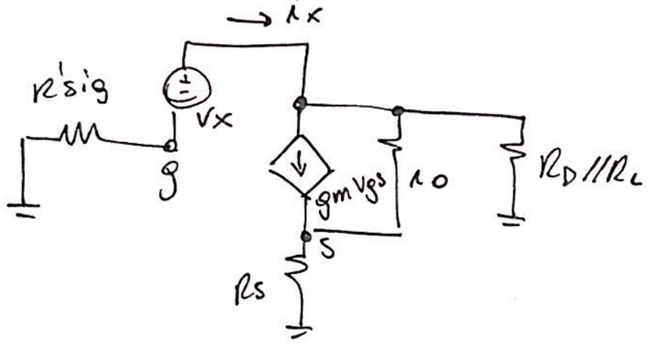
- Nota de aula CEA → Análise ω_H de amplificador common-source com R_S.

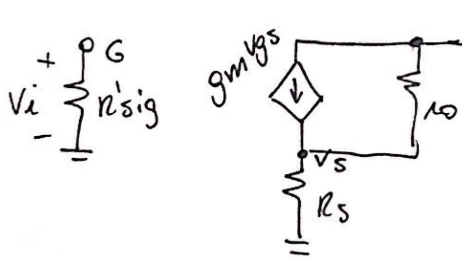


→ Levantando R_{gd}



→ Modelando o transistor pelo modelo norton

→



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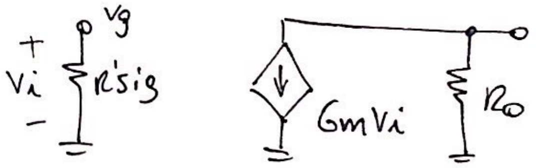
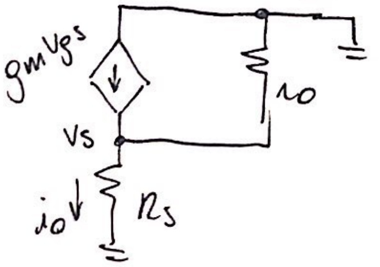


→ Sabe-se que $\boxed{R_o = R_s + r_o + g_m R_s r_o}$

→ Cálculo de G_m



$i_o = G_m V_i$

→ Sabe-se que $V_g = V_i$ e $V_S = i_o \cdot R_S$

logo, $v_{gs} = V_i - R_S i_o$

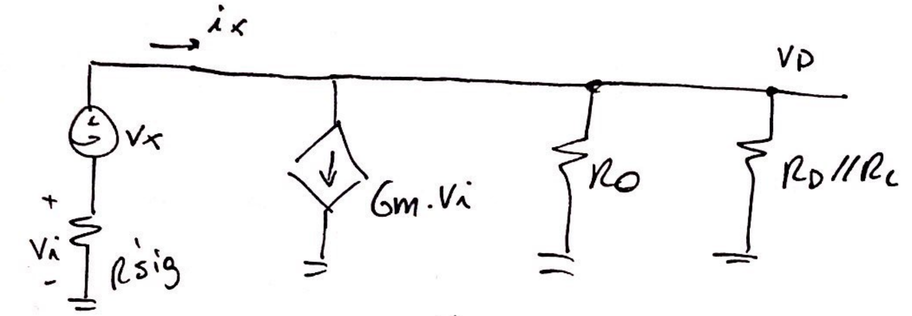
assim: $i_o = g_m v_{gs} + \left(\frac{-V_S}{r_o}\right)$

$i_o = g_m V_i - g_m R_S i_o - \frac{R_S}{r_o} \cdot i_o$

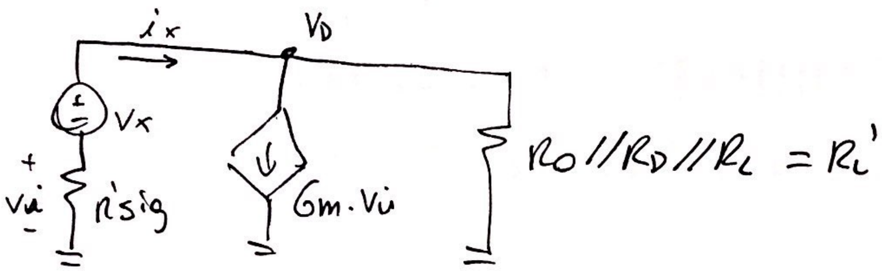
$i_o\left(g_m R_S + \frac{R_S}{r_o} + 1\right) = g_m V_i$

$$\boxed{G_m = \frac{g_m r_o}{r_o + R_S + g_m r_o R_S}}$$

Assim, o circuito vira:



$\Downarrow$

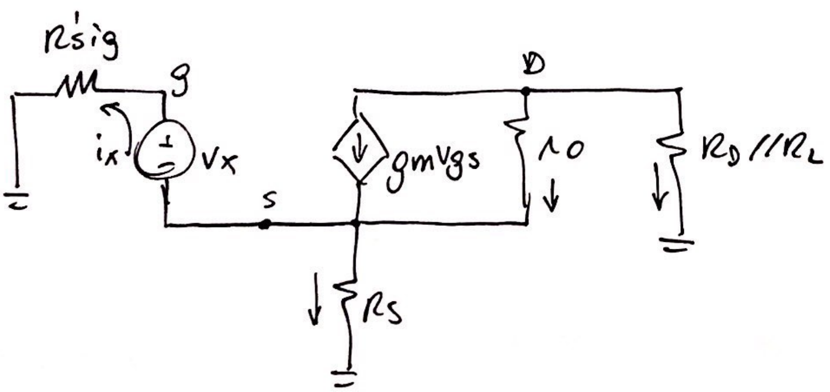


$V_i = -i_x \cdot R'_{sig} \longrightarrow V_D = V_x + V_i = V_x - R'_{sig}\, i_x$

$i_x = G_m \cdot V_i + \dfrac{V_D}{R_L'} \rightarrow i_x = -G_m R'_{sig}\, i_x + \dfrac{V_x}{R_L'} - \dfrac{R'_{sig}}{R_L'} \cdot i_x$

$i_x \left(1 + G_m R'_{sig} + \dfrac{R'_{sig}}{R_L'} \right) = \dfrac{V_x}{R_L'} \Rightarrow \boxed{\dfrac{V_x}{i_x} = R_{gd} = R_L' + G_m R_L' R'_{sig} + R'_{sig}}$

→ Levantando R_{gs}



→ Nó S: $i_x + \dfrac{V_S}{R_S} = g_m v_{gs} + \dfrac{V_D - V_S}{r_o}$

Nó D: $g_m v_{gs} + \dfrac{V_D - V_S}{r_o} + \dfrac{V_D}{R_D // R_L} = 0$

$v_{gs} = V_x$

$v_g = R'_{sig} \cdot i_x$

$V_S = R'_{sig} \cdot i_x - V_x$

Scanned with CamScanner

→ Assim,

Nó S: $$i_x + V_S\left(\frac{1}{R_S}+\frac{1}{r_o}\right) - g_m V_x = \frac{V_D}{r_o}$$

$$V_D = r_o i_x + V_S\left(1+\frac{r_o}{R_S}\right) - g_m r_o V_x$$

Nó D: $$g_m V_x + V_D\left(\frac{1}{r_o}+\frac{1}{R_D // R_L}\right) - \frac{V_S}{r_o}$$

$$g_m r_o V_x + V_D\left(1+\frac{r_o}{R_D//R_L}\right) - V_S = 0$$

→ Substituindo V_D na equação acima

$$g_m r_o V_x - V_S + \left(1+\frac{r_o}{R_D//R_L}\right)\left[r_o i_x + \left(1+\frac{r_o}{R_S}\right)V_S - g_m r_o V_x\right] = 0$$

$$r_o\left(1+\frac{r_o}{R_D//R_L}\right)i_x + \left(g_m \cancel{r_o} - g_m\cancel{r_o} - \frac{g_m r_o^2}{R_D//R_L}\right)V_x + \left[-1+\left(1+\frac{r_o}{R_D//R_L}\right)\left(1+\frac{r_o}{R_S}\right)\right]V_S = 0$$

$$\frac{r_o(R_D//R_L)+r_o^2}{R_D//R_L}\cdot i_x - \frac{g_m r_o^2}{R_D//R_L}V_x + \frac{(R_D//R_L)r_o + r_o R_S + r_o^2}{R_S\, R_D//R_L}\cdot V_S = 0$$

$$\left(r_o^2 R_S + r_o R_S (R_D//R_L)\right)i_x - g_m r_o^2 R_S V_x + \left[(R_D//R_L)r_o + r_o R_S + r_o^2\right]V_S = 0$$

→ Substituindo o valor de V_S:

$$0 = \left[r_o^2 R_S + r_o R_S(R_D//R_L)\right]i_x - g_m r_o^2 R_S V_x$$
$$+\left[(R_D//R_L)r_o + r_o R_S + r_o^2\right]R'_{sig}\, i_x - \left[(R_D//R_L)r_o + r_o R_S + r_o^2\right]V_x$$

$$V_x\left(g_m R_S r_o^2 + r_o^2 + (R_D//R_L)r_o + r_o R_S\right) = \left[r_o^2 R_S + r_o R_S(R_D//R_L) + (R_D//R_L)r_o R'_{sig} + r_o R_S R'_{sig} + r_o^2 R'_{sig}\right]i_x$$

$$\frac{V_x}{i_x} = R_{gs} = \frac{r_o^{\cancel{2}} R_S + \cancel{r_o} R_S(R_D//R_L) + (R_D//R_L)\cancel{r_o} R'_{sig} + \cancel{r_o} R_S R'_{sig} + r_o^{\cancel{2}} R'_{sig}}{\cancel{r_o} R_S + r_o^{\cancel{2}} + (R_D//R_L)\cancel{r_o} + g_m R_S r_o^{\cancel{2}}}$$

$$= \frac{(R_D//R_L + r_o)(R'_{sig}+R_S) + R'_{sig}R_S}{(R_D//R_L + r_o) + (g_m R_S r_o + R_S)}$$

$$\boxed{R_{gs} = \frac{R'_{sig} + R_S + R'_{sig}R_S/(R_D//R_L + r_o)}{1 + (g_m R_S r_o + R_S)/(R_D//R_L + r_o)}}$$

$$\boxed{\omega_H = \frac{1}{C_{gs}R_{gs} + C_{gd}R_{gd}}}$$