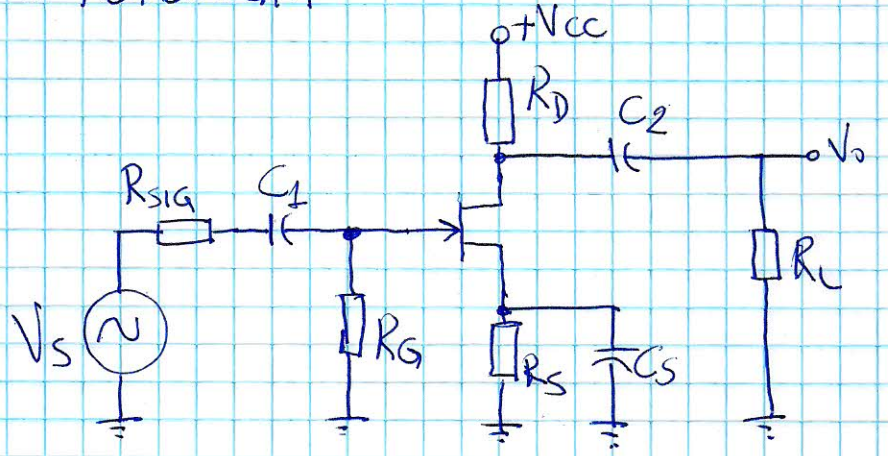
Análise Completa do Amplificador FET em Configuração de Autopolarização

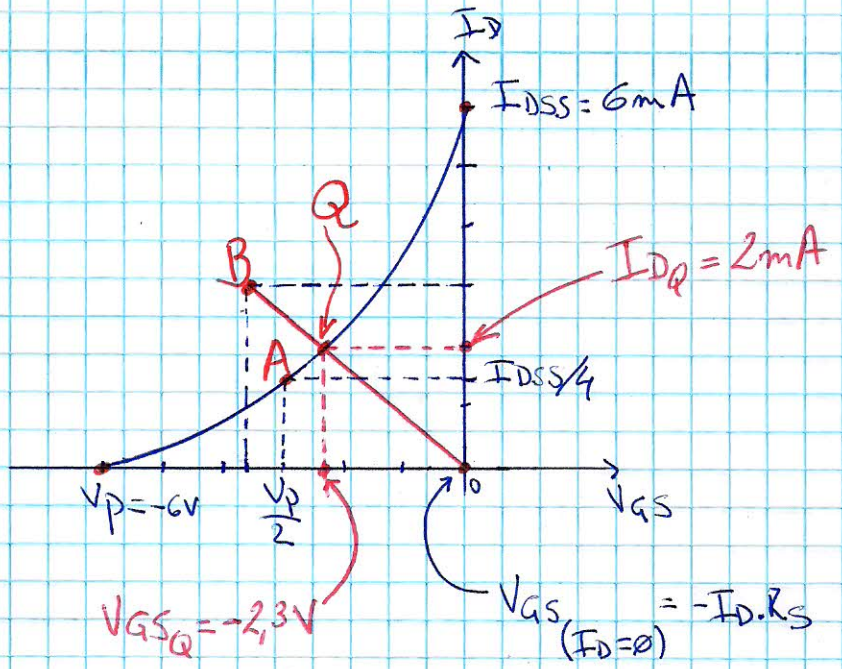
1. Topologia



2. Dados

$R_{SIG} = 1K\Omega$; $R_G = 1M\Omega$; $R_D = 3K\Omega$; $R_S = 2,2K\Omega$;
$R_L = 3,9K\Omega$; $C_1 = 0,1\mu F$; $C_2 = 4,7\mu F$; $C_S = 10\mu F$;
$I_{DSS} = 6mA$; $V_p = -6V$; $r_d = 100\Omega$; $C_{wi} = 3pF$;
$C_{wo} = 5pF$; $C_{gd} = 4pF$; $C_{gs} = 6pF$; $C_{ds} = 1pF$;
$V_{CC} = 18V$; $V_s = 10mV$

3. ANÁLISE DC



$A\left(\frac{V_P}{2}, \frac{I_{DSS}}{4}\right)$ $\quad \frac{V_P}{2} = -3V$, $\frac{I_{DSS}}{4} = 1,5mA$

$B\left(-\frac{I_{DSS}.R_S}{2}, \frac{I_{DSS}}{2}\right)$

$$-\frac{I_{DSS}.R_S}{2} = -\frac{6mA.1,2K\Omega}{2} = -3,6V$$

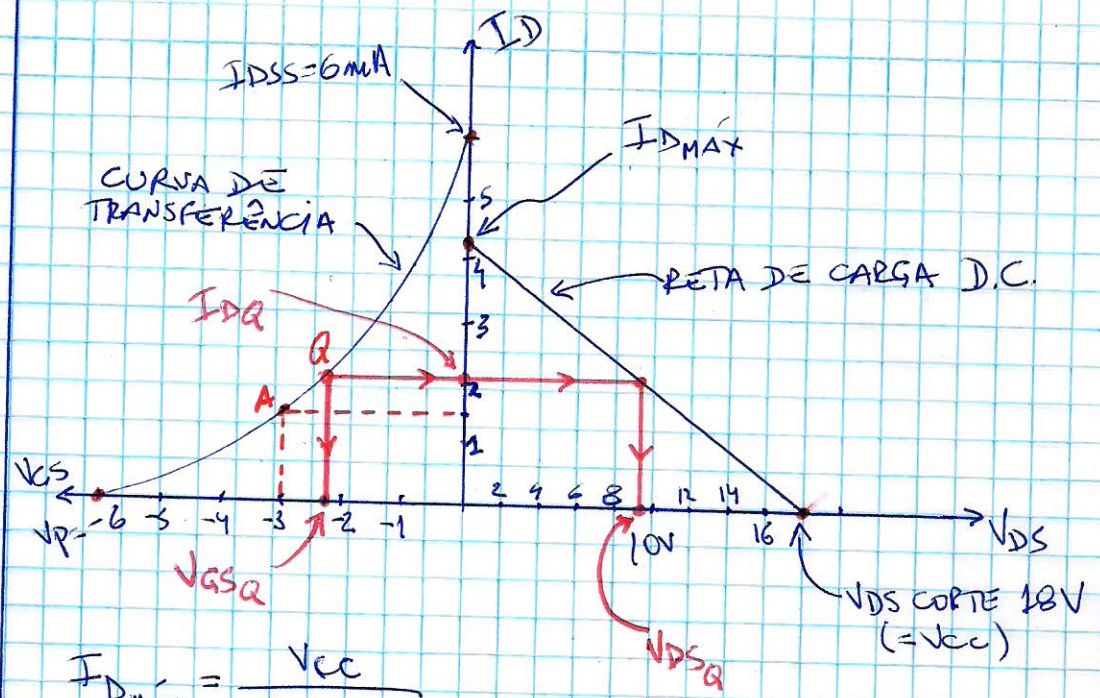
$$\frac{I_{DSS}}{2} = 3mA$$

$Q(-2,3V, 2mA)$

$V_S = I_{DQ}.R_S = 2mA.1,2K\Omega = 2,4V$

$V_{R_D} = I_{DQ}.R_D = 2mA.3K\Omega = 6V$

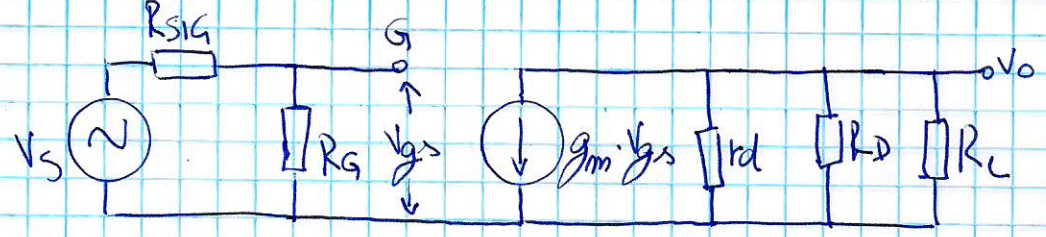
$V_{DS} = V_D - V_S = (V_{CC} - V_{R_D}) - V_S = (18-6) - 2,4 = 9,6V$



$$I_{D_{MÁX}} = \frac{V_{CC}}{R_D + R_S}$$

$$I_{D_{MÁX}} = \frac{18}{3K + 1,2K} = \frac{18}{4,2K} \cong 4,3mA$$

4. ANÁLISE A.C.



$$g_{m0} = \frac{2\,I_{DSS}}{|V_P|} = \frac{2 \cdot 6mA}{|-6V|} = 2mS$$

$$g_m = g_{m0}\left[1 - \frac{V_{GS}}{V_P}\right] = 2mS\left[1 - \frac{-2,3}{-6}\right] \cong 1,2mS$$

$$Z_i = R_G = 1M\Omega$$

$Z_o = rd // R_D$, como $rd \geq 10 \cdot R_D$: $Z_o = R_D = 3K\Omega$

$$A_{V_{NL}} = -g_m \cdot R_D \Big|_{rd \geq 10 \cdot R_D}$$

$$A_{V_{NL}} = -2mS \cdot 3K\Omega = -6$$

$$A_V = -g_m \cdot (R_D // R_L) \Big|_{rd \geq 10 \cdot (R_D // R_L)}$$

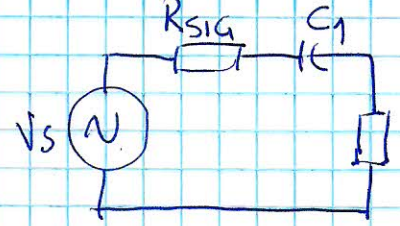
$$A_V = -2mS \cdot (3K\Omega // 3,9K\Omega) = -2mS \cdot 1,7K\Omega = -3,39$$

$V_o = A_V \cdot V_{gs}$, como $R_{SIG} \ll R_G$: $V_o = A_V \cdot V_S$

$$V_o = 3,39 \cdot 10mV = 33,9mV$$

5. Resposta em Baixa Frequência

5.1. Capacitor de Acoplamento de Entrada

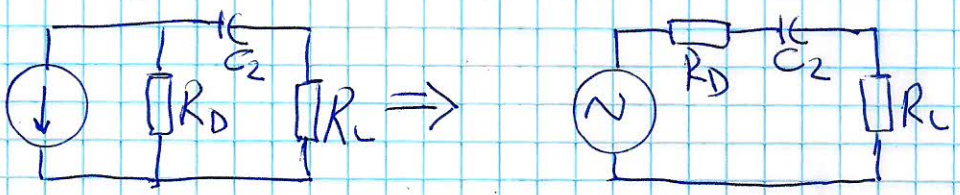


$$R = R_{SIG} + Z_i \qquad f_c = \frac{1}{2\pi R C_1}$$

$$R = 1K + 1M \cong 1M\Omega$$

$$f_c = \frac{1}{2\pi \cdot 1M \cdot 0,1\mu} \cong 1,6Hz$$

5.2. Capacitor de Acoplamento de Saída



$$R = R_D + R_L \qquad f_c = \frac{1}{2\pi R \cdot C_2}$$

$$f_c = \frac{1}{2 \cdot \pi \cdot (3K + 3,9K) \cdot 4,7\mu} \cong 5Hz$$

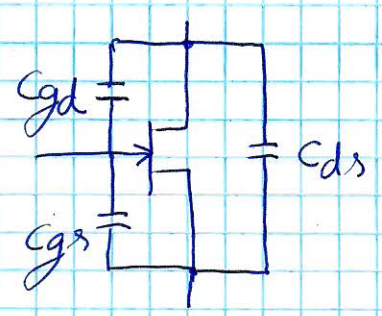
5.3. Capacitor de Desacoplamento de Source (Fonte)

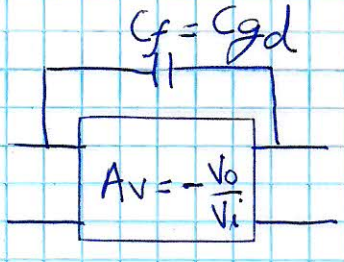
$$f_c = \frac{1}{2\pi R C_S} \qquad R = R_S \,//\, \frac{1}{g_m} \;\Big|\; r_d \cong \infty\Omega$$

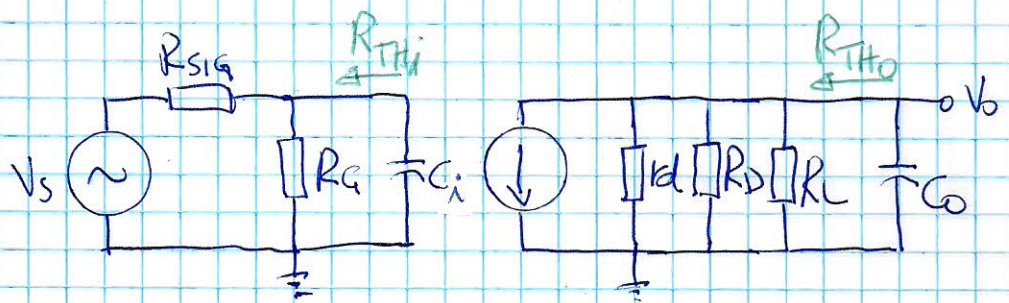
$$R = 1,2K \,//\, \frac{1}{1,2m} = 492\Omega$$

$$f_c = \frac{1}{2\pi \cdot 492 \cdot 10\mu} = 32,4Hz$$

6. RESPOSTA EM ALTA FREQUÊNCIA







$C_{Mi} = (1 - A_V) C_{gd}$

$C_{Mi} = (1 - (-3,39)) \cdot 4p$

$C_{Mi} \cong 17,6pF$

$C_i = C_{wi} + C_{gs} + C_{Mi}$

$C_i = 3p + 6p + 17,6p$

$C_i = 26,6pF$

$R_{THi} = R_{SIG} // R_G$

$R_{THi} \cong R_{SIG} = 1K\Omega$

$f_{Hi} = \frac{1}{2\pi \cdot R_{THi} \cdot C_i}$

$f_{Hi} = \frac{1}{2\pi \cdot 1K \cdot 26,6p} \cong 6MHz$

$C_{Mo} = \left(1 - \frac{1}{A_V}\right) C_{gd}$

$C_{Mo} = \left(1 - \frac{1}{-3,39}\right) \cdot 4p$

$C_{Mo} \cong 5,2pF$

$C_o = C_{wo} + C_{ds} + C_{Mo}$

$C_o = 5p + 1p + 5,2p$

$C_o = 11,2pF$

$R_{THo} = rd // R_D // R_L \cong R_D // R_L$

$R_{THo} = 3K // 3,9K = 1,7K\Omega$

$f_{Ho} = \frac{1}{2\pi \cdot R_{THo} \cdot C_o}$

$f_o = \frac{1}{2\pi \cdot 1,7K \cdot 11,2p} \cong 8,3MHz$

L.T.S.

"DUAS COISAS SÃO INFINITAS: O UNIVERSO E A ESTUPIDEZ HUMANA. MAS, EM RELAÇÃO AO UNIVERSO, AINDA NÃO TENHO CERTEZA ABSOLUTA"

ALBERT EINSTEIN