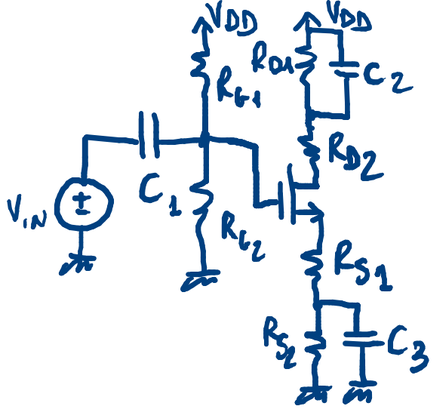


$C_2 = 1\,mF$

$C_3 = 1\,mF$

$C_1 = 1\,\mu F$

$K = \mu_n C_{ox} \frac{W}{L} = 2\,m\frac{A}{V^2}$

$VT = 1V$

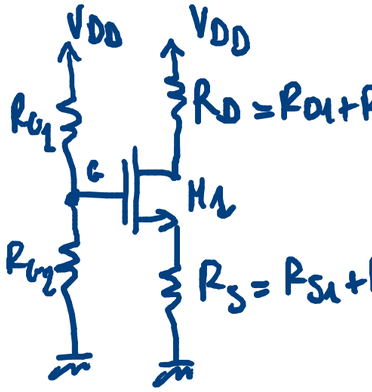
$V_{DD} = 12V$

$R_{S1} = R_{S2} = 1\,k\Omega$

$R_{D1} = R_{D2} = 4\,k\Omega$

$R_{G2} = 10\,k\Omega$

$R_{G1} = 20\,k\Omega$



$R_D = R_{D1} + R_{D2} = 8\,k\Omega$

$R_S = R_{S1} + R_{S2} = 2\,k\Omega$

M_p: M_1 è saturo $\Rightarrow I_{DS} = \frac{k}{2}(V_{GS} - V_T)^2$

$\begin{cases} V_{GS} \geq V_T \\ V_{DS} \geq V_{GS} - V_T \end{cases}$

$V_G = \frac{R_{G2}}{R_{G1} + R_{G2}} V_{DD}$

$V_G = V_{GS} + R_S I_{DS}$

$V_G = V_{GS} + R_S \frac{K}{2}(V_{GS} - V_T)^2$

$\frac{R_S}{2} K V_{GS}^2 + (1 - R_S K V_T) V_{GS} + \frac{R_S K V_T^2}{2} - V_G = 0$

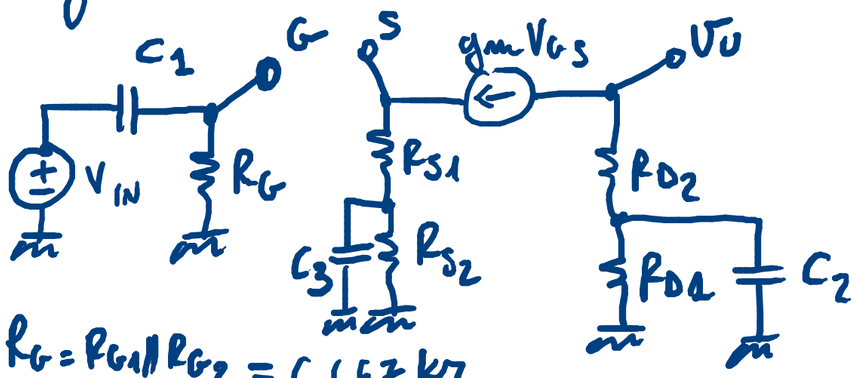
$2V_{GS}^2 - 3V_{GS} - 2 = 0$

$V_{GS} = \begin{cases} 2V \\ -0{,}5V \end{cases} \Rightarrow I_{DS} = 1\,mA$

$V_{DS} = V_D - V_S = \underbrace{V_{DD} - R_D I_{DS}}_{V_D} - \underbrace{R_S I_{DS}}_{V_S} = 2V$

$V_{DS} = 4V \geq V_{GS} - V_T = 1V$ ok saturazione

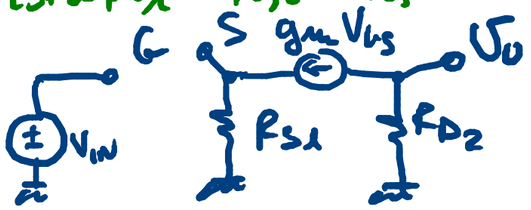
$g_m = 2mS$



$R_G = R_{G1} \| R_{G2} = 6{,}667\ k\Omega$

$$A_V(s) = \frac{V_U}{V_{IN}} = \frac{A_{V\infty} s (s+\omega_{o1})(s+\omega_{o2})}{(s+\omega_{p1})(s+\omega_{p2})(s+\omega_{p3})}$$

Se $s \to +\infty$



$$A_{V\infty} = -\frac{g_m R_{D2}}{1 + g_m R_{S1}} \neq 0$$

$$\omega_{p1} = \frac{1}{R_{Vc1} C_1} = \frac{1}{C_1 R_G}$$

$$\omega_{p2} = \frac{1}{R_{Vc2} C_2} = \frac{1}{C_2 R_{D1}}$$

$R_{Vc2} = R_{D1} \| [R_{D2} + R_{V_{DRAIN}}]$ $\quad R_{V_{DRAIN}} \to +\infty$

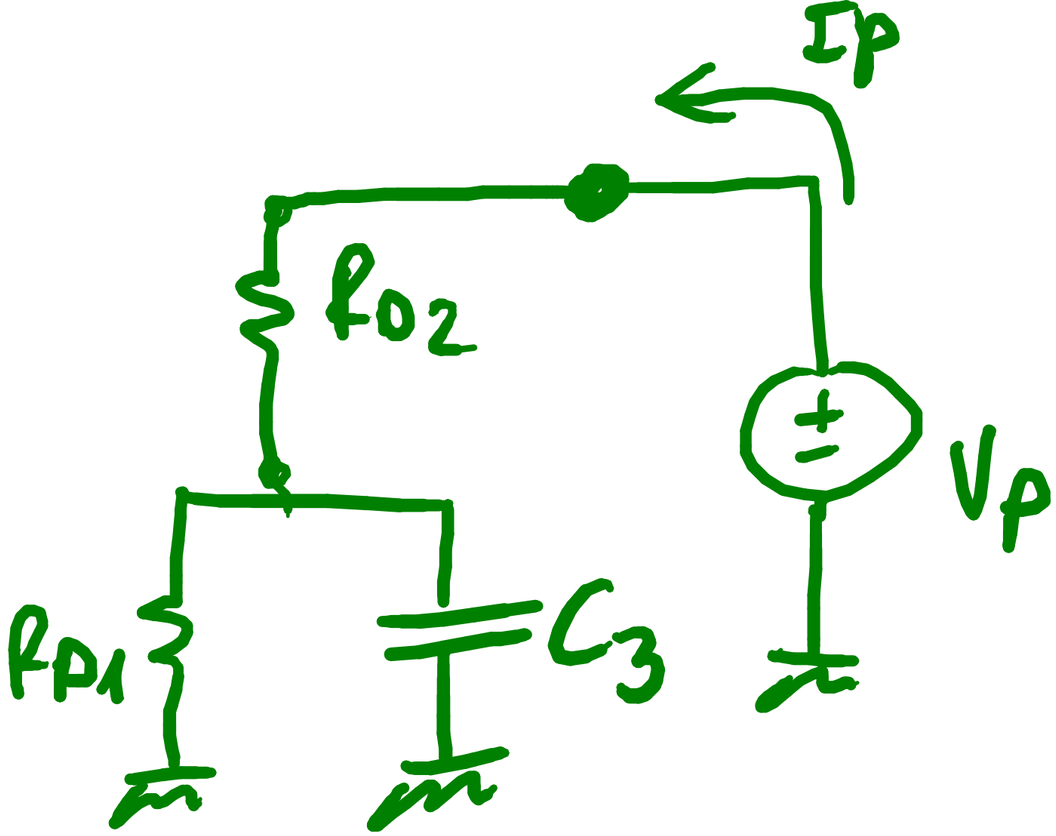
e quindi $R_{Vc2} = R_{D1}$

$$\omega_{p3} = \frac{1}{C_3 R_{Vc3}} \qquad R_{Vc3} = R_{S2} \| [R_{S1} + R_{V_{SOURCE}}]$$

$$R_{V_{SOURCE}} = \frac{1}{g_m}$$

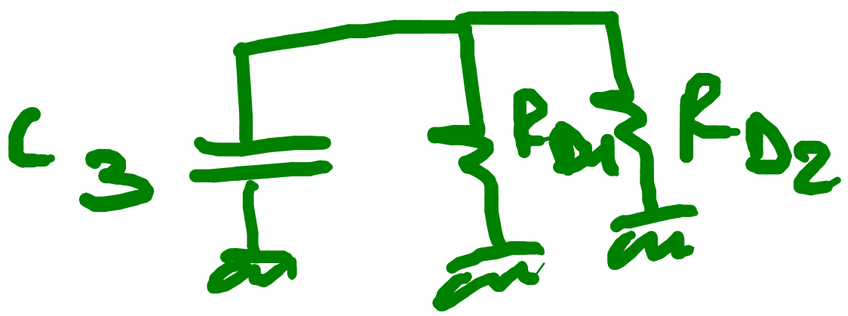
$$R_{Vc3} = R_{S2} \| \left[R_{S1} + \frac{1}{g_m}\right]$$

$$\omega_{o1} = \frac{1}{C_3 R_{C2}}$$



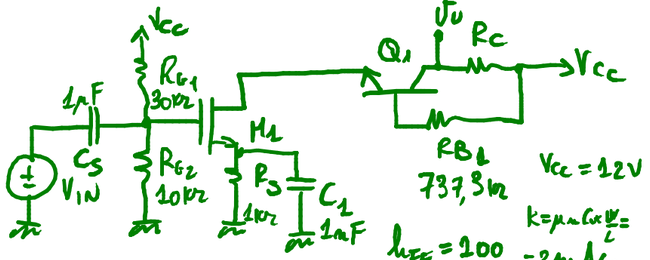
$$\frac{V_p}{I_p} = Z_{out} = R_{O2} + R_{D1} \| \frac{1}{C_3 s} = 0$$

$$Z_{out} = \frac{V_p}{I_p} \qquad V_{out} \approx \frac{I_p}{V_p}$$



$$\overline{W_p} = \frac{1}{C_3 R_{VC3}} = \frac{1}{C_3 R_{D1} \| R_{O2}}$$

$$W_{O2} = \overline{W_p}$$

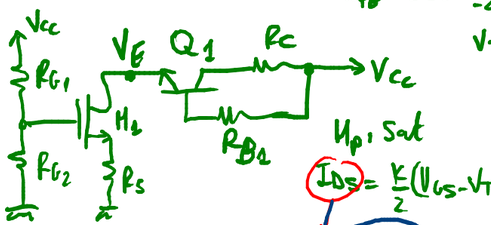


$V_{CC} = 12V$

$k = \mu_n C_{ox} \frac{W}{L} = 2 mA/V^2$

$V_T = 1V$

$h_{FE} = 100$



V_{p1} Sat

$I_{DS} = \frac{K}{2}(V_{GS} - V_T)^2$

$V_G = \frac{R_{G2}}{R_{G1}+R_{G2}} V_{CC}$

$V_G = V_{GS} + R_S I_{DS}$

$V_{GS} = \frac{K}{2} V_{GS} + R_S \frac{K}{2}(V_{GS} - V_T)^2$

$V_{GS} = \begin{cases} 2V \\ -1V \end{cases}$ $V_{GS} \geq V_T \Rightarrow I_{DS} = 1mA$

$I_{DS} = I_E = (h_{FE}+1) I_B \qquad I_B = \frac{I_{DS}}{h_{FE}+1} = 9,901 \mu A$

$I_C = h_{FE} I_B = 990,1 \mu A$

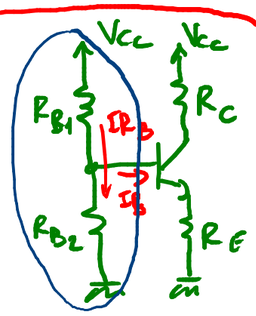
$V_E = V_D = V_{CC} - R_{B1} I_B - V_{BEON} = 4V$

$V_{DS} = V_D - V_S = 3V \geq V_{GS} - V_T = 1V$ OK Sat. M1

$V_{CE} \geq V_{CEsat} = 0,1V$

$V_C - V_E = V_{CC} - R_C I_C - V_E = 3,05V \geq V_{CEsat}$

OK Zona Attiva Diretta per Q1

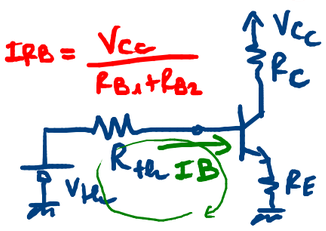


h_{FE} Noto

Se $I_{RB} \gg I_B$ Hp. PP

$V_B = \frac{R_{B2}}{R_{B1}+R_{B2}} V_{CC}$

$I_{RB} = \frac{V_{CC}}{R_{B1}+R_{B2}}$

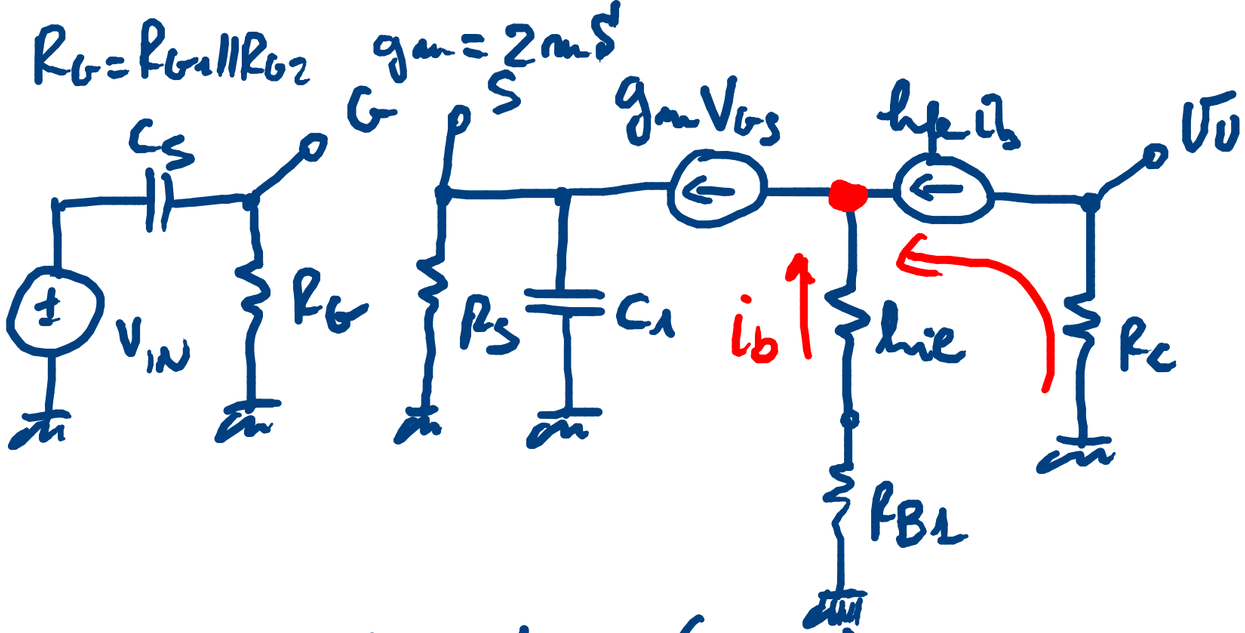


$R_{TH} = R_{B1} \| R_{B2}$

$V_{TH} = \frac{R_{B2}}{R_{B1}+R_{B2}} V_{CC}$

$V_{TH} = R_{TH} I_B + V_{BEON} + R_E (h_{FE}+1) I_B$

$\frac{V_{TH} - V_{BEON}}{R_{TH} + R_E (h_{FE}+1)} = I_B$



$$A_V(s) = \frac{V_U(s)}{V_{IN}(s)} = \frac{A_{V0}\, s(s+\omega_0)}{(s+\omega_{p1})(s+\omega_{p2})}$$

per $s \to +\infty$ $\quad V_U = -R_C h_{fe} i_b$

$V_G = V_{IN}$ $\wedge$ $V_S = 0 \Rightarrow V_{GS} = V_{IN}$

$g_m V_{GS} = (h_{fe}+1) i_b \Rightarrow i_b = \frac{g_m V_{GS}}{h_{fe}+1}$

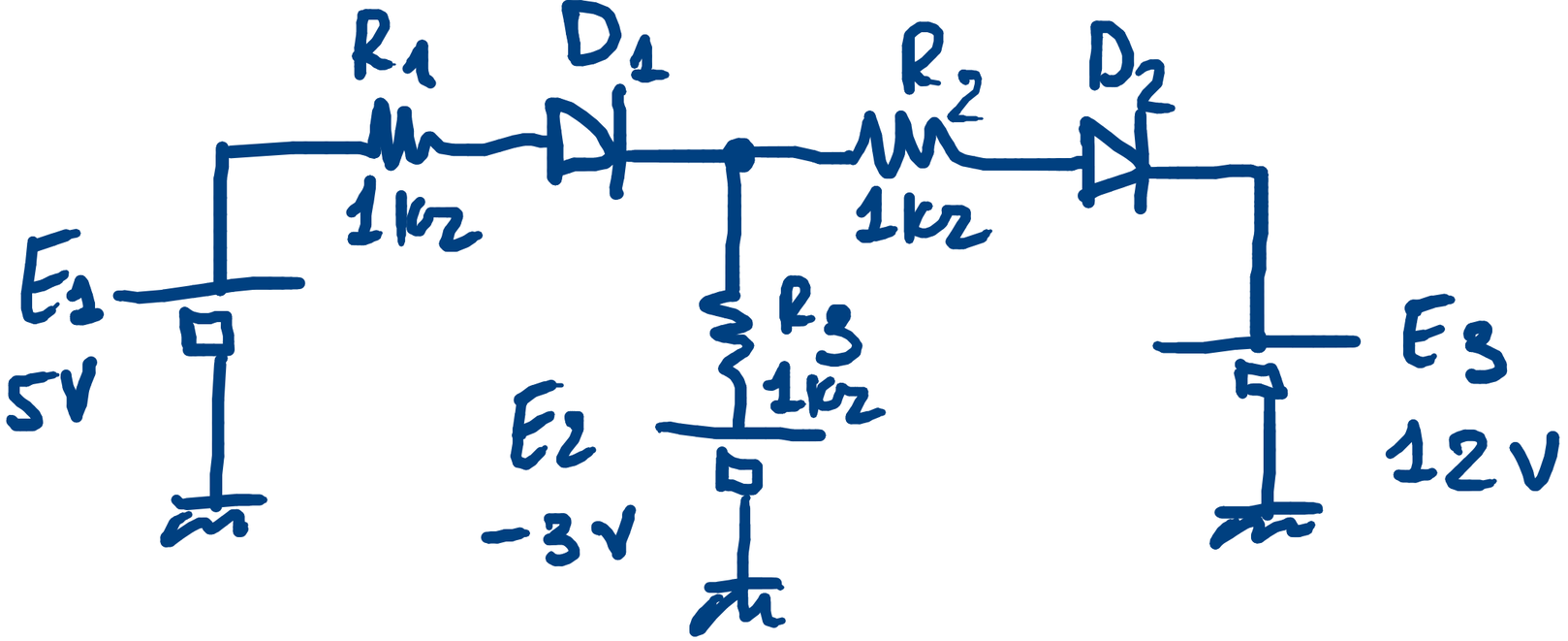
$V_U = -\frac{R_C h_{fe} g_m V_{IN}}{h_{fe}+1}$

$A_{V0} = -9{,}967$

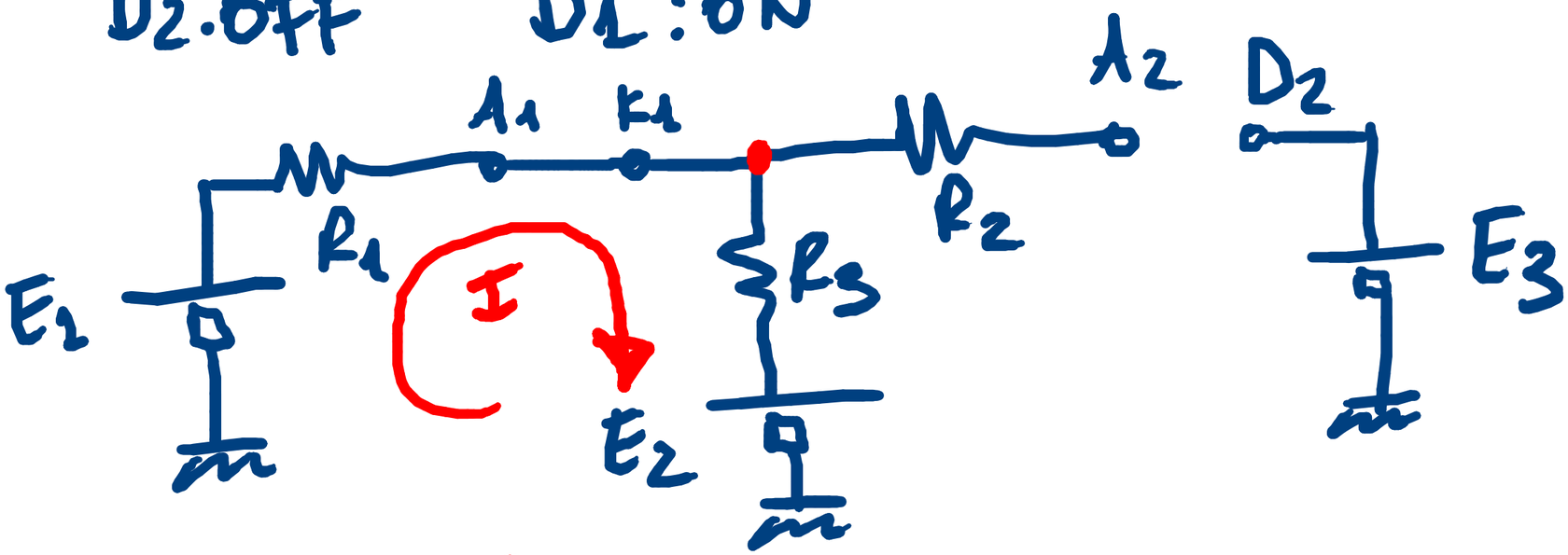
$\omega_0 = \frac{1}{C_1 R_S} = 1\,Mrad/s$

$\omega_{p1} = \frac{1}{C_S R_G} = 133{,}3\,rad/s$

$\omega_{p2} = \frac{1}{C_1 R_{VS}} = 3\,Mrad/s$ $\quad R_{VS} = R_S \| \frac{1}{g_m}$



D_2: OFF D_1: ON



$$I = \frac{E_1 - E_2}{R_1 + R_2} = 4\,mA$$

$V_{A2D_2} < 0$ $\quad V_{D_2} = 12V$

$V_{A_2} = E_2 + R_3 I = 1V$ $\quad V_{k_2D_2} = -11V$