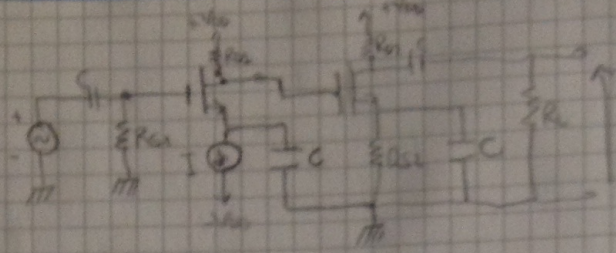
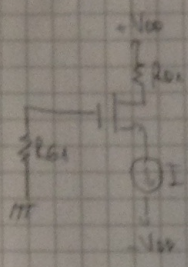
23/02/2022



①



$V_{GS} = V_G - V_S$

$I_D = k(V_{GS} - V_T)^2 \rightarrow 2 = 0.5(V_S + 1)^2 = 0$

$4 = V_S^2 + 1 + 2V_S = 0$

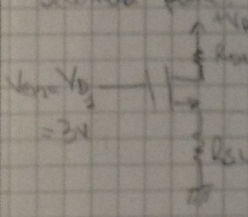
$V_S^2 + 2V_S - 3 = 0 \rightarrow$

$\frac{-2 \pm \sqrt{4+12}}{2} = \begin{cases} -3 \Rightarrow V_{GS} = 3 > 2 \\ 1 \Rightarrow V_{GS} = -1 < 2 \end{cases}$

$V_{GS} \geq V_{GS} - V_T = 2$

$V_D - V_S = (V_{DD} - I_D R_{D2}) - (V_G - V_S) = 6$ OK

Seconda parte:



$\rightarrow \begin{cases} V_{GS} = V_G - V_S = 3 - I_D R_{S2} \\ I_D = k(V_{GS} - V_T)^2 = 1 \end{cases}$

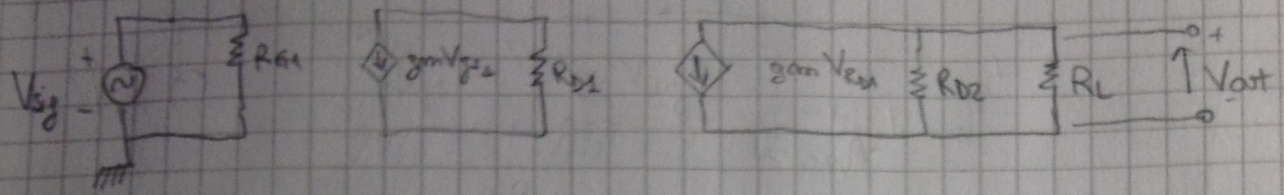
$V_{GS} = 3 - 1(V_{GS} - 1)^2 = 3 - (V_{GS}^2 + 1 - 2V_{GS}) = 0 \quad -V_{GS}^2 + 2V_{GS} + 2 = 0$

$\frac{-1 \pm \sqrt{1+8}}{-2} = \begin{cases} 2 > 1 \text{ OK} \\ -1 \rightarrow \text{no} \end{cases}$ $\quad V_{GS_2} = 2\text{V}$

$V_{DS} \geq V_{GS} - V_T = 1\text{V}$

$\rightarrow V_D - V_S = (+V_{DD} - \underbrace{I_D R_{D2}}_{=2}) - (V_G - V_{GS}) = 2\text{V} > 1$ OK

$V_G = 3, \quad V_{GS} = 2, \quad -1$



$$V_{out} = -R_L /\!/ R_{D2} \cdot g_{m2} V_{RD1} = -R_L /\!/ R_{D2} \cdot g_{m2} \cdot (-g_{m1} V_{gs1}) \cdot R_{D1} = + R_L /\!/ R_{D2} \cdot g_{m1} \cdot g_{m2} \cdot V_{sig} \cdot R_{D1}$$

$g_{m1} = 2K (V_{GS1} - V_T) = 1 (3-1) = 2$

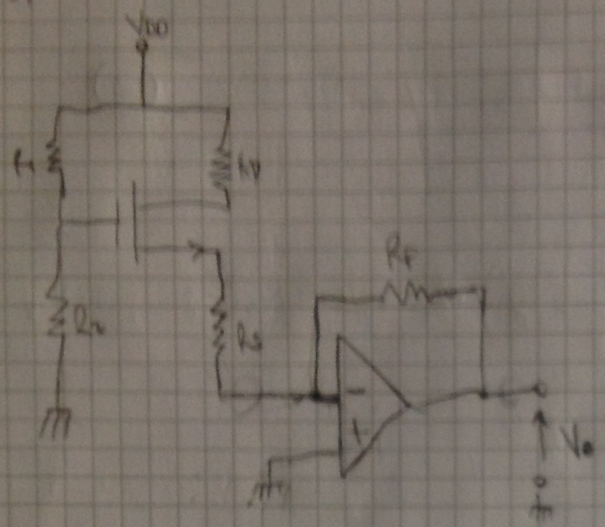
$g_{m2} = 2K (V_{GS2} - V_T) = 2 (2-1) = 2$

$R_L /\!/ R_{D2} = 2 /\!/ 2 = 1$

$V_{out} = 1 \cdot 2 \cdot 2 \cdot 1 \cdot V_{sig} \rightarrow \boxed{A = 4}$

OK

3/3/2011



$V_{DD}=5V$ $R_1=20k\Omega$ $R_2=8k\Omega$
$R_D=2\Omega$ $R_S=500\Omega$ $R_F=3k\Omega$
$V_T=1V$ $K=0,5$ $|L^+|=|L^-|=15V$

$V_{GS}=V_G-V_S>V_T=1V$

$V_{DD}\cdot\frac{R_2}{R_2+R_1}=\frac{4}{5}\cdot 5=4$

$V_o=-\frac{R_F}{R_S}V_S=-6V_S$

$V_{GS}=4-V_S$

$$\begin{cases} V_S=I_D R_S=1_{\Omega}\cdot I_D \\ I_D=K(V_{GS}-V_T)^2 \end{cases} \Rightarrow$$

$V_S=I_D\cdot 0,5$

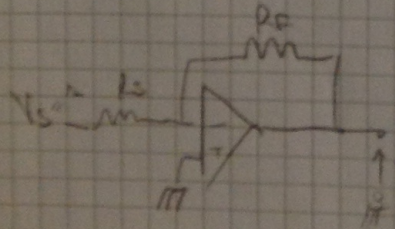
$I_D=0,5\left(4-I_D\cdot 0,5-1\right)^2 \Rightarrow 2I_D=0,25I_D^2+9-3I_D$

$0,25I_D^2-5I_D+9=0$

$I_D^2-20I_D+36=0$

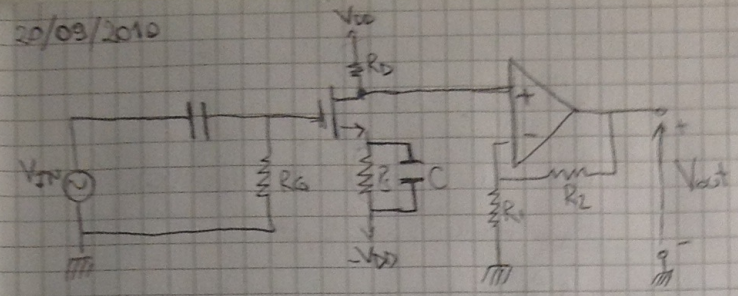
$\frac{+20\pm\sqrt{400-144}}{2}$ / $\frac{4}{2}=2\Rightarrow$ OK

(18)



$V_O=\left(-\frac{R_F}{R_S}\right)V_S=-6V$

20/09/2010



$R_G = 10K\Omega$ $R_D = 2.5K\Omega$ $R_1 = 1K\Omega$
$R_2 = 4K\Omega$ $V_{DD} = 5V$

$|V_{sat}^+| = |V_{sat}^-| = 5V$

$V_T = 1V$ $K = 0.5$

1) Dimensionare R_S in modo che la tensione continua ϕ
2) con R_S trovare A

$V_{GS} > V_T = 1$

$\Rightarrow V_{GS} = V_G - V_S = 0 - (R_S \cdot I_D - (-V_{DD})) = -R_S \cdot I_D - V_{DD}$

$$\begin{cases} V_D = V_{DD} - R_D \cdot I_D = 0 \\ I_D = K(V_{GS} - V_T)^2 \end{cases} \Rightarrow 0 = 5 - 2.5 I_D \Rightarrow I_D = 2$$

$2 = 0.5 (V_{GS} - V_T)^2$

$4 = V_{GS}^2 + 1 - 2V_{GS} \Rightarrow$

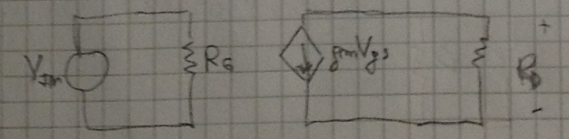
$V_{GS}^2 - 2V_{GS} - 3 = 0$

$\frac{+2 \pm \sqrt{4+12}}{2}$ $\begin{cases} -1 \text{ NO} \\ 3 \text{ OK} \end{cases}$

$3 I_D$

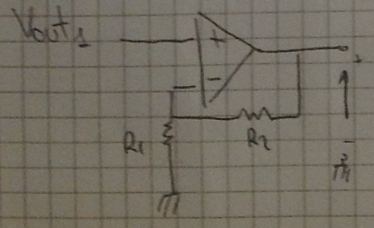
$V_{GS} = 3V$
$I_D = 2mA$

$2V_{DD} = I_D R_D + V_{GS} + I_D R_S \Rightarrow \boxed{R_S = 1K\Omega}$



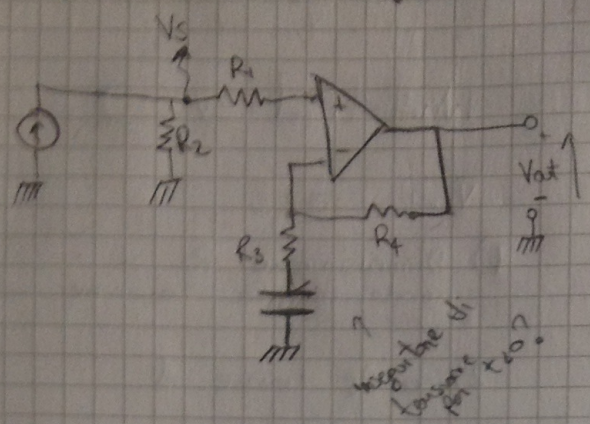
$V_{out_1} = -g_m V_{in} \cdot R_D = -5 V_{in}$

$2K(V_{GS} - V_T) = 2$



$V_{out_2} = V_{out_1} \cdot \left(1 + \frac{R_2}{R_1}\right) = V_{out_1} \cdot 5 = -25 V_{in}$

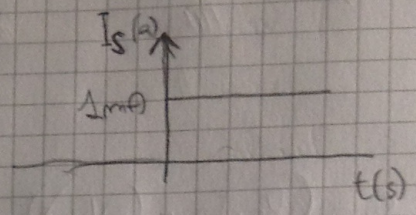
12 LUGLIO 2010 (fatto ma non svolto)



$|L^+| = |L^-| = 12V$

$R_1 = 2K\Omega \quad R_2 = 2K\Omega \quad R_3 = 1K\Omega$

$R_4 = 4K\Omega \quad C = 1\,\mu F$



$V_C = I_S \cdot R_2 = 2V$

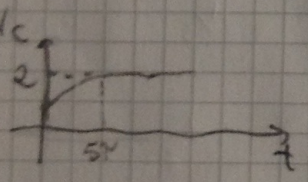
$V_{out} = V_{out_1} + V_{out_2}$

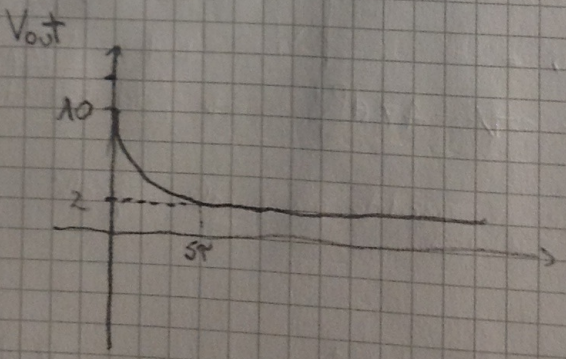
$V_{out_1} = \left(1 + \frac{R_4}{R_3}\right) V_S = 10 \qquad V_{out_2} = \left(-\frac{R_4}{R_3}\right) V_C$

$V_{out} = 10 - 4V_C$

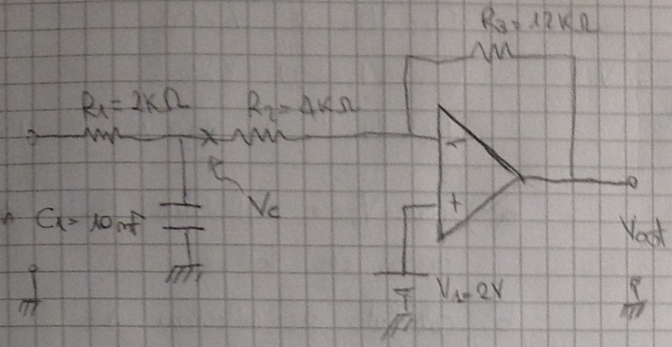
$V_C(t) = V_C(\infty) - [V_C(\infty) - V_C(t_0)]\, e^{-\frac{t-t_0}{\tau}} = 2 - 2e^{-\frac{t}{\tau}}$

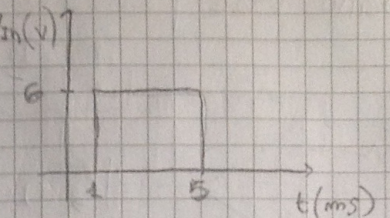
$V_C(\infty) = 2 \qquad V_C(\infty) = 2 \qquad V_C(t_0) = 0$





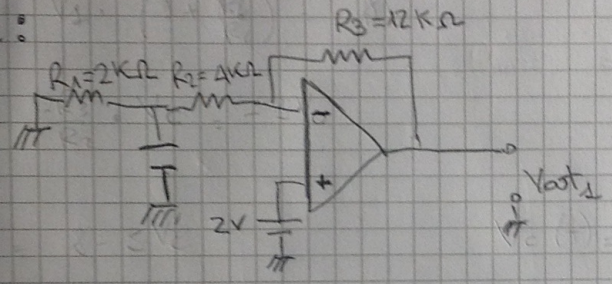
10 NOVEMBRE 2010 (Batta) OK





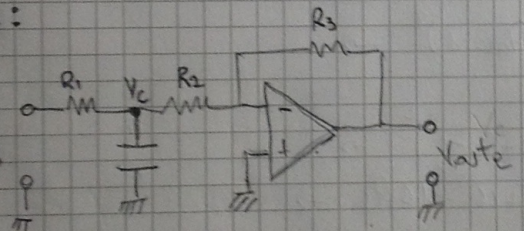
$V_{out} = V_{out_1} + V_{out_2}$ (sovrapposizione degli effetti)

V_{out_1}:



$$V_{out_1} = 2V \cdot \left(1 + \frac{R_3}{R_1 + R_2}\right) = 6V$$

V_{out_2}:



$$V_{out_2} = V_c \cdot \left(-\frac{R_3}{R_2}\right) = -3V_c$$

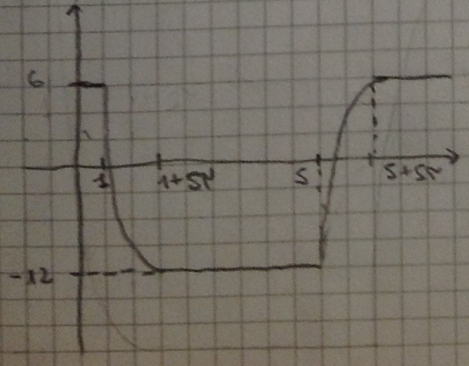
$$V_c(t) = V_c(\infty) - \left[V_c(0) - V(1^-)\right] e^{\frac{-t-1^-}{\tau}} = 6 - 6\, e^{\frac{-t-1}{\tau}}$$

$V_c(\infty) = 6$ $\quad V_c(0) = 6$ $\quad V(1^-) = 0$

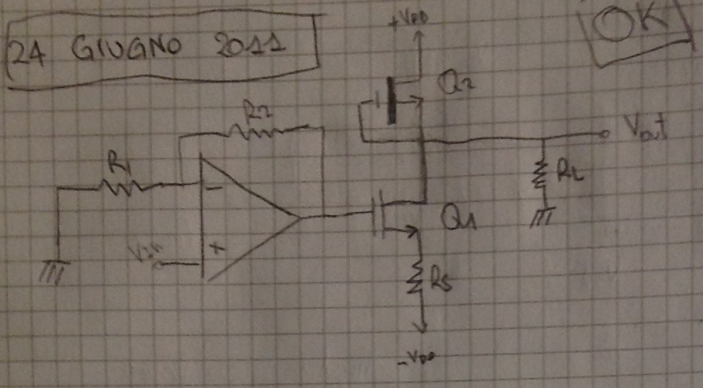
con $\tau = R_1 /\!/ R_2 \cdot C = \frac{R_1 \cdot R_2}{R_1 + R_2} \cdot C = \frac{2 \cdot 4}{2+4} \cdot 10^3 \cdot 10 \cdot 10^{-9} = \frac{40}{3} \cdot 10^{-6} = \frac{40}{3}\ \mu Sec$

$V_{out} = V_{out_1} + V_{out_2} = 6 - 3V_c$

(Il condensatore da in tempo a caricarsi perché $5\tau < \Delta t$)



24 GIUGNO 2011



OK

Q_1: $V_T = 1V$ $K = 0,5$

Q_2: $V_T = -2V$ $K = 0,5$

$V_{DD} = 5V$ $R_1 = 2$ $R_2 = 10$ $R_L = 1S$

a) con $V_I = 0$ calcolare R_S in modo che $V_{out} = 0$

b) calcolato R_S calcolare A

a) Q_2: $V_{GS_2} > V_T \Rightarrow 0 > -2$ OK

$$I_D = K(V_{GS} - V_T)^2 = K(-V_T)^2 = 2mA$$

$$V_{DD} = V_{DS_2} + V_{DS_1} + I_D R_S - V_{DD}$$

$$\begin{cases} V_{GS1} = V_G - V_S \\ \quad \| \quad \| \\ I_D = K(V_{GS} - V_T)^2 \end{cases} \Rightarrow \begin{cases} V_{GS} = -2R_S + 5 \\ 2 = 0,5(V_{GS} - 1)^2 \rightarrow \end{cases}$$

$$4 = (-2R_S + 5 - 1)^2 \rightarrow$$

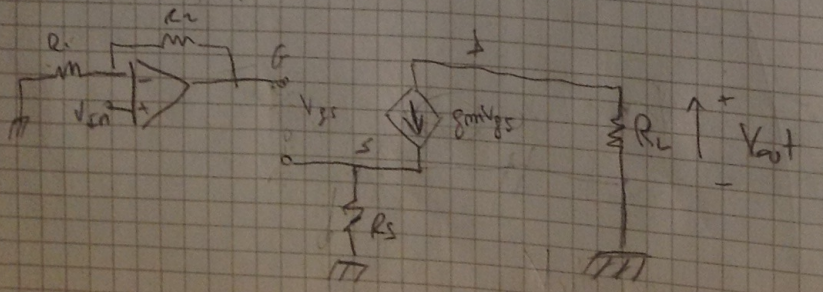
$$4 = 4R_S^2 + 16 - 16R_S \rightarrow$$

$$4R_S^2 - 16R_S + 12 = 0$$

$$\frac{+16 \pm \sqrt{256 - 96}}{8} = \begin{cases} 3 \\ 1 \rightarrow \text{OK} \end{cases}$$

$R_S = 1K\Omega$

$$g_m = 2K(V_{GS} - V_T) = 2$$



$V_{out} = -g_m V_{gs} \cdot R_L$ 24 giugno 2011 (continuo)

$g_m = 2K(V_{gs} - V_T) = 2$

$V_{gs} = V_g - V_s = V_g - IR_S = V_g - g_m V_{gs} R_S$

$+V_g = g_m V_{gs} R_S + V_{gs} = V_{gs}(1 + g_m R_S)$

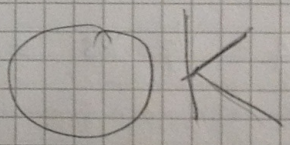
$V_{gs} = \frac{V_g}{1 + g_m R_S}$

$V_{out} = -\frac{g_m R_L}{1 + g_m R_S} V_g = \frac{-g_m R_L}{1 + g_m R_S} \cdot 6 V_{in}$

$A = -\frac{2 \cdot 15}{1 + 2} \cdot 6 = -60$

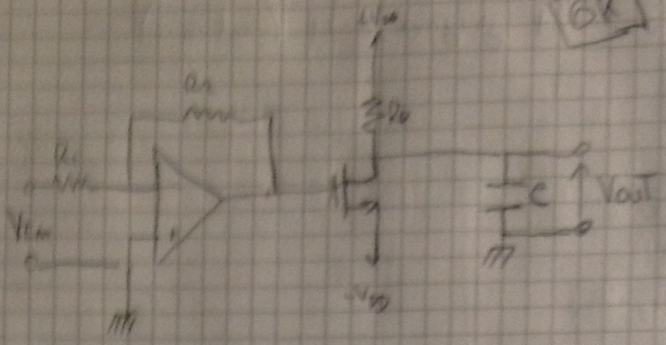
N.B. se $g_m R_S \gg 1$

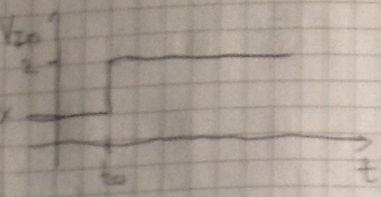
$A = \frac{V_{out}}{V_G} = -\frac{g_m R_L}{g_m R_S}$



6K

19/04/2021





Q: $V_T = 2V$ $K = 0,2 S$
$V_{DD} = 5V$ $R_L = 2k\Omega$ $R_1 = 1k\Omega$
$R_2 = 3k\Omega$ $C = 2mF$

Calcolare V_x in modo che $V_{out} = 0$ fino a t_0

$V_D = 0 = V_{DD} - R_2 I_D \Rightarrow \frac{V_{DD}}{R_2} = I_D = 1,5mA$

$I_D = 1,5 = K (V_{GS} - V_T)^2 = 0,2 (V_{GS} - 2)^2 \Rightarrow 4 = V_{GS}^2 + 4 - 4V_G$

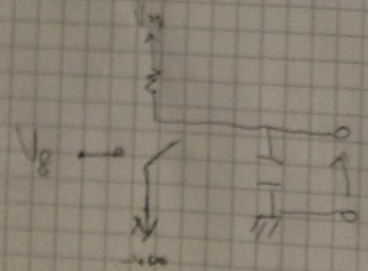
$V_{GS} = 4 = V_G - V_S = V_G + V_{DD} \Rightarrow V_G = -1$

$V_X \cdot \left(-\frac{R_2}{R_1}\right) = V_G \Rightarrow -V_X \cdot 4 = -1 \Rightarrow V_X = \frac{1}{4}$

② $\tau = R_2 C = 3 \cdot 2 \cdot 10^{-3} \cdot 10^3 = 10 \cdot 10^{-6} = 10 \mu S$

$V_C(t_0) = 0$

$V_G = -V_{in} \cdot 4 = -8$ $\quad V_{GS} = V_G - V_S = -8 + 5 = -3$ OFF

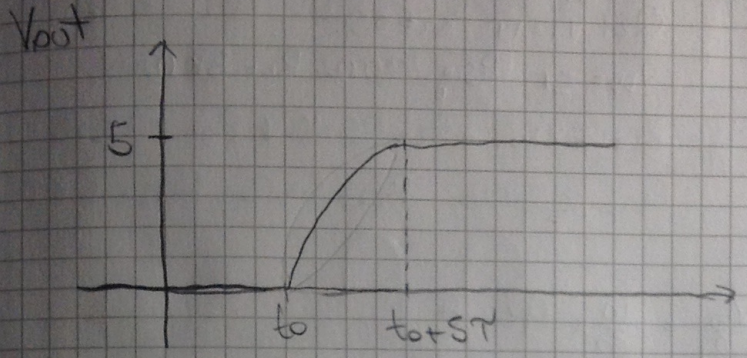


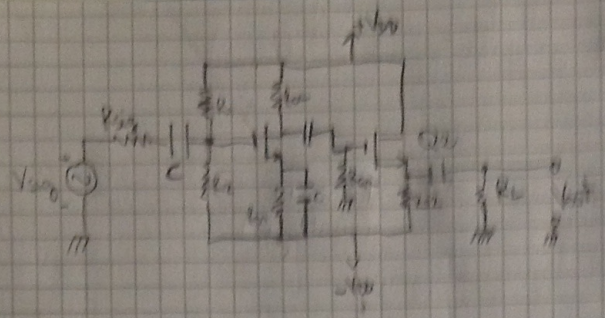
$\rightarrow V_C(\infty) = 5$

$$V_c(t) = V_c(\infty) - \left(V_c(\infty) - V_c(t_0)\right) e^{\frac{-t-t_0}{\tau}} = 5 - 5\,e^{\frac{-t-t_0}{\tau}}$$

$V_c(\infty) = 5$ $\quad$ $V_c(t_0) = 0$

19/04/2012
(continua)





Q_1: $V_{GS} = V_G - V_S$

$2V_{DD} = V_{R1} + V_{R2} = I(R_1 + R_2) \Rightarrow I = \frac{2V_{DD}}{R_1 + R_2} = \frac{10}{50} = 0.2\,mA$

$V_{R2} = R_2 \cdot I = 30 \cdot 0.2 = 6\,V$

$V_{R2} = V_G - (-V_{DD}) = 6 \Rightarrow \boxed{V_G = 6 - 5 = 1\,V}$

$$\begin{cases} V_S = I_D \cdot R_{S2} - V_{DD} = I_D \cdot 1.5 - 5 \\ I_D = K(V_{GS} - V_T)^2 \end{cases}$$

$V_G = (-V_{DD}) = I_D R_{S1}$

$V_S + V_{DD} = I_D R_{S1}$

$V_S = I_D R_{S1} - V_{DD}$

$I_D = 0.5(1 - 1.5I_D + 5 - 1)^2$

$2I_D = 25 + 2.25 I_D^2 - 15 I_D \Rightarrow 2.25 I_D^2 - 17 I_D + 25 = 0$

$I_D = \frac{17 \pm \sqrt{17^2 - 225}}{4.5}$ → 5.5 / 2

visto che $V_{GS} = 1 - (I_D \cdot 1.5 - 5) =$

$1 - (3 - 5) = 3$ ← OK

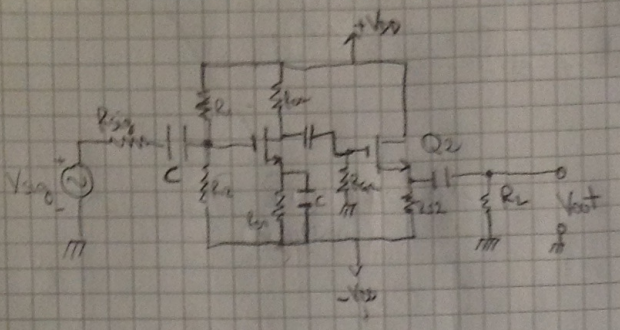
$1 - (8.25 - 5) = -2.25$ ← NO

$\boxed{V_{GS} = 3 > 1}$

$V_D = 5 - 2.2 = 2.8$

$\boxed{V_{DS} = 3}$

16/09/2011



•) calcolare il guadagno $A = \frac{V_{out}}{V_{in}}$

Q_1: $V_T = 1V$ $K_1 = 0.5$
Q_2: $V_T = 1V$ $K_2 = 0.5$
$V_{DD} = 5V$ $R_{sig} = 50\Omega$ $R_L = 3K\Omega$
$R_1 = 30K\Omega$ $R_2 = 30K\Omega$ $R_{D1} = 2K\Omega$
$R_{S1} = 1.5K\Omega$ $R_{S2} = 6K\Omega$ $R_{G2} = 8K\Omega$

Q_1: $V_{gs} = V_G - V_S$

$2V_{DD} = V_{R1} + V_{R2} = I(R_1 + R_2) \Rightarrow I = \frac{2V_{DD}}{R_1+R_2} = \frac{10}{50} = 0.2\,mA$

$V_{R2} = R_2 \cdot I = 30 \cdot 0.2 = 6\,V$

$V_{R2} = V_G - (-V_{DD}) = 6 \Rightarrow \boxed{V_G = 6 - 5 = 1}$

$\begin{cases} V_S = I_D \cdot R_{S1} - V_{DD} = I_D \cdot 1.5 - 5V \\ I_D = K(V_{gs} - V_T)^2 \end{cases}$

$\boxed{\begin{array}{l} V_S - (-V_{DD}) = I_D R_{S1} \\ V_S + V_{DD} = I_D R_{S1} \\ V_S = I_D R_{S1} - V_{DD} \end{array}} \leftarrow$

$I_D = 0.5(1 - 1.5I_D + 5 - 1)^2$

$2I_D = 25 + 2.25I_D^2 - 15I_D \Rightarrow 2.25I_D^2 - 17I_D + 25 = 0$

$\frac{+17 \pm \sqrt{289 - 225}}{4.5} \quad \begin{array}{l} \nearrow 5.5 \\ \searrow 2 \quad \text{Si} \end{array}$

visto che $V_{gs} = 1 - (I_D \cdot 1.5 - 5) =$
$1 - (3 - 5) = 3 \leftarrow OK$
$1 - (8.25 - 5) = -2.25 \leftarrow NO$

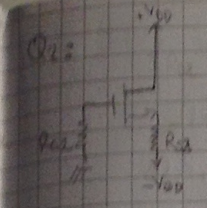
$\boxed{V_{gs} = 3 > 1}$

$V_D = 5 - 2.2 = 1$

$\boxed{V_{DS} = 3}$

16/09/2011
continua

Q2:



$V_{GS_2} = V_G - V_S = 0 - V_S = -I_D R_{S2} + V_{DD}$

$V_S - (-V_{DD}) = I_D R_{S1} \Rightarrow V_S = I_D R_{S1} - V_{DD}$

$I_D = K (V_{GS} - V_T)^2 = 0{,}5 \left(-I_D \cdot 6 + 5 - 1\right)^2$

$2 I_D = 36 I_D^2 + 16 - 48 I_D$

$36 I_D^2 - 50 I_D + 16 = 0$

$\frac{+50 \pm 14}{72} \begin{cases} \frac{1}{2} \\ \frac{64}{72} \end{cases}$

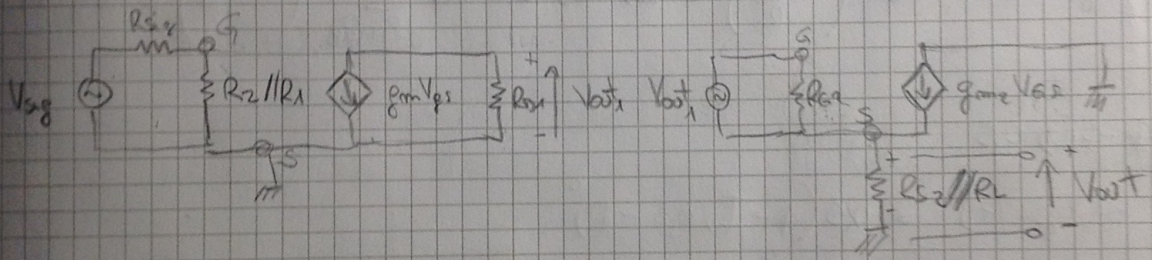
$V_{GS_2} = -\frac{1}{2} \cdot 6 + 5 = 2 > 1$ OK

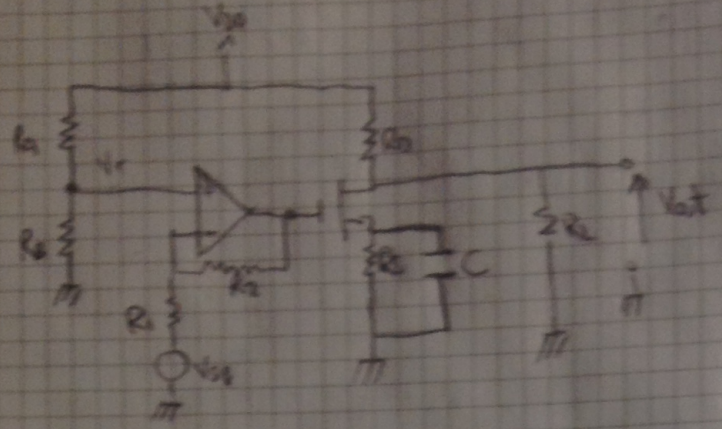
$V_{GS} = -\frac{64}{72} \cdot 6 + 5 = -5{,}33 + 5 < 1$ NO

$V_{GS_2} = 2$

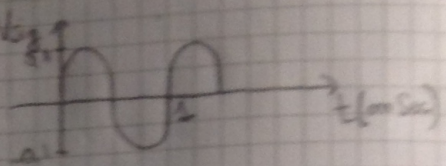
$V_{DS} \geq V_{GS} - V_T = 1$

$V_D - V_S = 5 - 2 = 3$ OK





$R_D = 3k\Omega$ $R_{S2} = 1k\Omega$
$R_1 = 2k\Omega$ $R_2 = 6k\Omega$
$R_S = 0.5k\Omega$ $R_D = 2k\Omega$
$R_L = 10k\Omega$ $V_{DD} = 10V$
$L^+ = -L^- = 10V$



$V_T = 1V$ $K = 0.5$

- grafare V_{out}

Vediamo la polarizzazione:

$V_{gs} > V_T = 1V$

$\hookrightarrow V_g - V_S = V_{R2} \cdot \left(1 + \frac{R_1}{R_2}\right) - I_D \cdot R_S = V_{DD} \cdot \frac{R_2}{R_1 + R_2} \cdot \left(1 + \frac{R_1}{R_2}\right) - I_D R_S$

$$\begin{cases} V_{gs} = 4 - I_D 0.5 \\ I_D = K(V_{gs} - V_T)^2 \end{cases}$$

$V_{gs} = 4 - 0.5 (V_{gs} - 1)^2 \cdot 0.5$

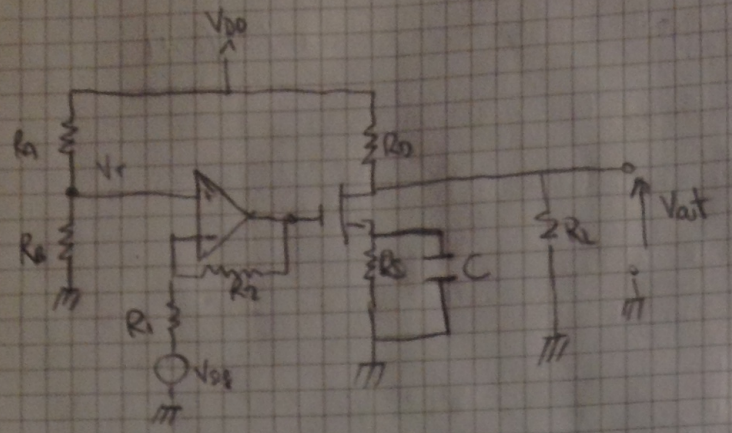
$4V_{gs} = 16 - (V_{gs} - 1)^2 = 16 - (V_{gs}^2 + 1 - 2V_{gs})$

$-V_{gs}^2 - 2V_{gs} + 15 = 0$

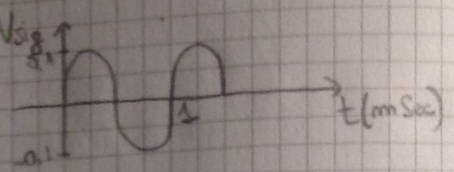
$\frac{+2 \pm \sqrt{4 + 60}}{-2}$ $\cdot 5$ / -5

$\sqrt{\ } \rightarrow$ OK $\rightarrow I_D = K(V_{gs} - 1)^2 = 2mA$

V_{gs}



$R_A = 3K\Omega$ $R_B = 1K\Omega$
$R_1 = 2K\Omega$ $R_2 = 6K\Omega$
$R_S = 0{,}5K\Omega$ $R_D = 2K\Omega$
$R_L = 10K\Omega$ $V_{DD} = 10V$
$L^+ = -L^- = 10V$



$V_T = 1V$ $K = 0{,}5$

- graficare V_{out}

Vediamo la polarizzazione:

$V_{gs} > V_T = 1V$

$\hookrightarrow V_g - V_s = V_{RB} \cdot \left(1 + \frac{R_1}{R_2}\right) - I_D \cdot R_S = V_{DD} \cdot \frac{R_B}{R_A + R_B} \cdot \left(1 + \frac{R_1}{R_2}\right) - I_D \cdot R_S$

$$\begin{cases} V_{gs} = 4 - I_D\, 0{,}5 \\ I_D = K(V_{gs} - V_T)^2 \end{cases}$$

$$V_{gs} = 4 - 0{,}5\,(V_{gs} - 1)^2 \cdot 0{,}5$$

$$4V_{gs} - 16 - (V_{gs} - 1)^2 = 16 - (V_{gs}^2 + 1 - 2V_{gs})$$

$$-V_{gs}^2 - 2V_{gs} + 15 = 0$$

$$\frac{+2 \pm \sqrt{4 + 60}}{-2} \quad -5 \quad / \quad -5$$

$\sqrt{3}$ V_{gs} $\rightarrow$ OK $\rightarrow$ $I_D = K(V_{gs} - 1)^2 = 2mA$

$V_D = V_{DD} - R_D I_{RD}$

$I_{RD} = I_D + I_{RL}$

$\downarrow$

$\frac{V_{DD} - V_D}{R_D} = 2 + \frac{V_D}{R_L}$

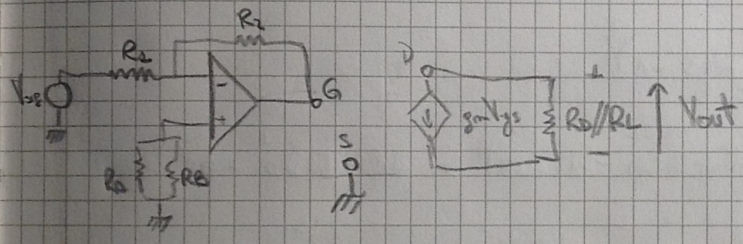
$\Downarrow$

$\frac{10 - V_D}{2} = 2 + \frac{V_D}{10}$ $\quad V_D = 5$ (il segnale in uscita si muove intorno a 5)

$V_{DS} \geq V_{GS} - V_T = 2$

$\Rightarrow V_D - V_S = 5 - \underbrace{I_D \cdot R_S}_{2 \cdot 0,5} = 4 > 2$ OK $\rightarrow$ sto in saturazione

vediamo per piccoli segnali:



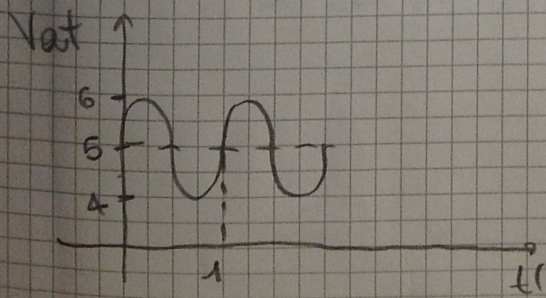
$g_m = 2K(V_{GS} - V_t) = 2$

$R_D // R_L = 2 // 10 = \frac{2 \cdot 10}{12} = \frac{10}{6}$

$V_{out} = -g_m V_{gs} \; R_D // R_L = -\frac{10}{3} V_{gs} = 10\, V_{sig}$

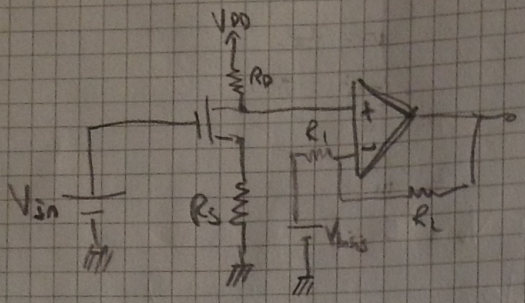
$V_{gs} = \left(-\frac{R_2}{R_1}\right) V_{sig} = -3\, V_{sig}$

$\Rightarrow V_{out} = 10\, V_{sig}$ "sommando" le due componenti (quella costante che è uguale a V_D e questo V_{out}) otteniamo l'andamento



8 gennaio 2010 chiedere consegna

$V_{DD} = 10V$ $V_{in} = 5V$ $R_D = 2$ $R_S = 2$
$R_1 = 1$ $R_2 = 4$
T: { V=1 K=1.5 }



$$V_{out} = 0 = V_D\left(1 + \frac{R_2}{R_1}\right) + V_{basis}\left(-\frac{R_2}{R_1}\right) = 5V_D - 4V_{basis} = 0$$

$V_{gs} \geq V_T = 1$

↳ $V_g - V_S = V_{in} - I_D R_D = 5 - I_D \cdot 2 = V_{gs}$

$I_D = k(V_{gs} - V_T)^2 = 1.5(V_{gs} - 1)^2$

$2I_D = 3(4 - 2I_D)^2 = 3(16 + 4I_D^2 - 16I_D) = 48 + 12I_D^2 - 48I_D$

$12I_D^2 - 50I_D + 48 = 0 \Rightarrow \frac{+50 \pm \sqrt{2500 - 2304}}{24} = \frac{+50 \pm 14}{24}$

$\frac{64}{24} = \frac{8}{3} \approx 2.7$

$\frac{36}{24} = \frac{3}{2} = 1.5$ ok

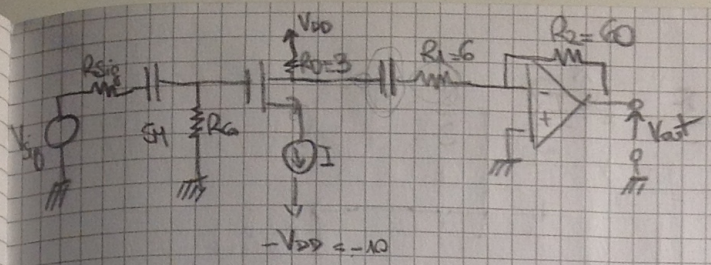
$V_{gs} = 5 - 3 = 2$ ok $I_D = 1.5mA$

$V_{DS} \geq V_{gs} - V_T = 1$

↳ $V_D - V_S = V_{DD} - I_D R_D - V_S = 4$

$V_D = V_{DS} + V_S = 4 + 3 = 7$

$5V_D - 4V_{basis} \Rightarrow 35 = 4V_{basis} \Rightarrow V_{basis} = \frac{35}{4}$



OK

20/11/2021

sapendo che

$A = \frac{V_{out}}{V_{in}} = 80$

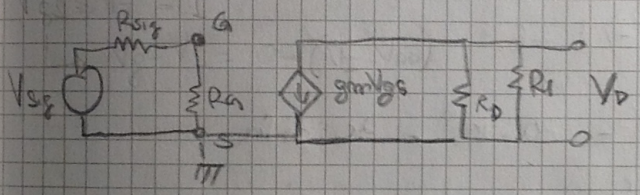
dimensionare I ?

con $V_T = 1$ $K = 2$

$$A = A_t \cdot A_a = \frac{V_D}{V_{sig}} \cdot \frac{V_{out}}{V_D} = 80$$

sapendo che: $\frac{V_{out}}{V_D} = -\frac{R_2}{R_1} = -10$ sappiamo che $\frac{V_D}{V_{sg}} = -8$

supponiamo saturazione:



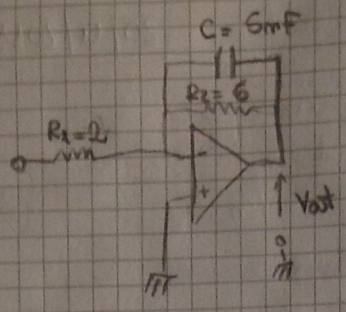
$V_D = -g_m R_1 // R_D \; V_{sg} \Rightarrow \frac{V_D}{V_{sg}} = -g_m R_1 // R_D = -8$

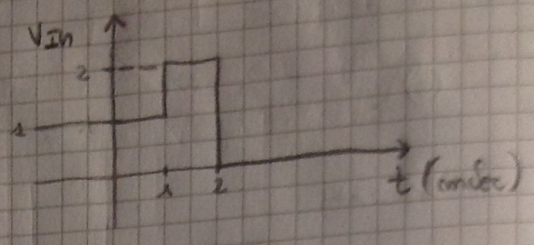
$g_m R_1 // R_D = 8 \Rightarrow g_m \frac{6 \cdot 3}{6+3} = 8 \Rightarrow g_m = 4$

$g_m = 2K (V_{gs} - V_T) = 4 (V_{gs} - 1) \Rightarrow V_{gs} = 2$

$I = I_D = K (V_{gs} - V_T)^2 = 2 (2-1)^2 = 2\,mA$

- occhio alla seconda domanda





il condensatore, messo come un integratore reale, vede Vout attualmente è un circuito aperto

$$V_{out}(-\infty, 1^-) = -\frac{R_2}{R_1} \cdot V_{in} = -3$$

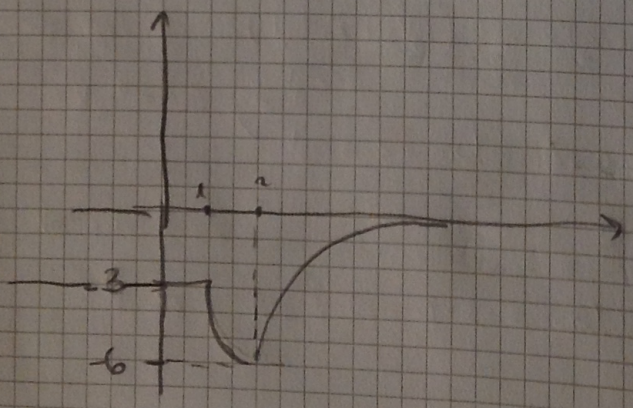
$$V_{out}(1^+, 2^-) = -V_c(t) = -\left(V_c(\infty) - (V_c(\infty) - V(1^+)) e^{-\frac{t-1}{\tau}} \right) =$$

$V_c(\infty) = -V_{out} = 6$; $V_c(\infty) = 6$; $V(1^+) = 3$

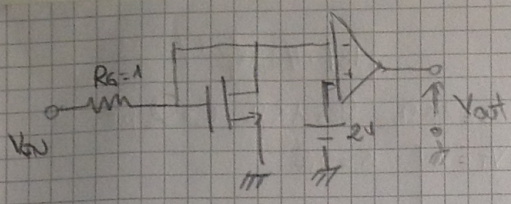
$$= -\left(6 - (6-3) e^{-\frac{t-1}{\tau}}\right) = -\left(6 - 3 e^{-\frac{t-1}{\tau}}\right) = -6 + 3 e^{-\frac{t-1}{\tau}}$$

con $\tau = R_2 \cdot C = 6 \cdot 10^3 \cdot 5 \cdot 10^{-3} = 30 \cdot 10^{-6} = 30\ \mu Sec$

visto che $5\tau \ll 1\ mSec$ il condensatore si carica tutto poi, durante il secondo secondo si scarica fino a $\emptyset$



- Se non ci fosse stato R_2 veniva un integratore: ingresso lineare → uscita rampa



Q: $\begin{cases} V_T = 1V \\ K = 2 \end{cases}$

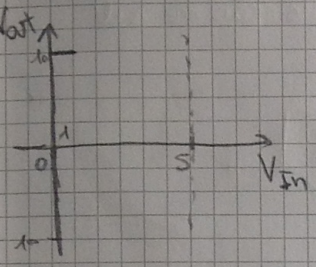
$V^+ = -V^- = 10V$

disegnare la transcaratteristica tra 0 e 5 volt

(significa che devo disegnare il grafico V_{out}/V_{in})

↓

varia tra 0 e 5



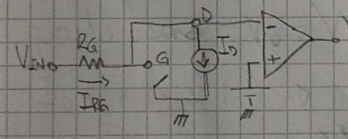
quando in entrata il segnale V_{in} non supera 1V (V_T) allora il transistor va in saturazione positiva perché $V_+ > V_-$ ($V_{out} = 10V$)

quando $V_I > 1$ la situazione cambia:

$V_{GS} > V_T$

↳ $V_G - V_S = 1^+ - 0 = 1^+ > 1$ (transistor ON

V_{DS} è sicuramente > $V_{GS} - V_T$ perché gate e drain sono cato-cacciati.



com: $I_D = K(V_{GS} - V_T)^2$

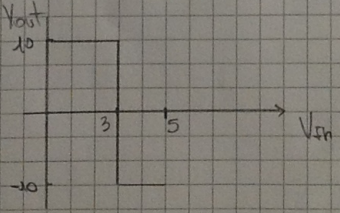
Q2

$\begin{cases} V_{GS} = V^- = 2 \\ V_{IN} - V_{RG} = V_{GS} \Rightarrow V_{IN} - \underbrace{K(V_{GS} - V_T) R_G}_{V_{RG}} = V_{GS} = V^- = 2 \end{cases}$

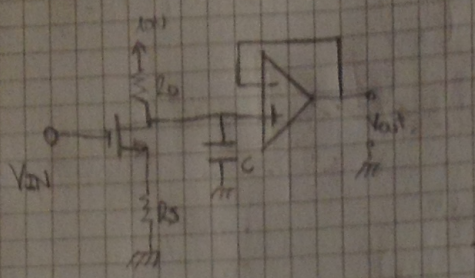
$I_D R_G$

quand'è che V^- vale 2 (e supera V^+)?

$V_{in} - 1(V_G - V_T)^2 \cdot 1 = 2 \Rightarrow V_{in} - 1 = 2 \Rightarrow V_{in} = 3$

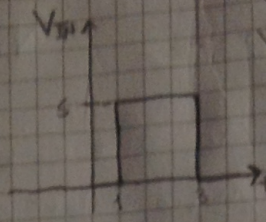


18/01/2011



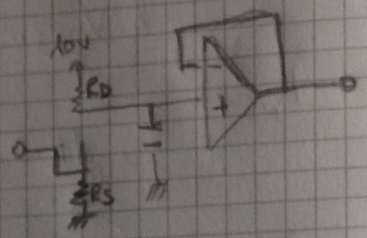
$R_D = 2K\Omega$ $R_S = 1K\Omega$ $C = 1\mu F$

$V_T = 1V$ $K = 0,5$



La funzione dell'amplificatore è solo quella di abbassare della tensione sul condensatore:

$V_{out} = V_C$



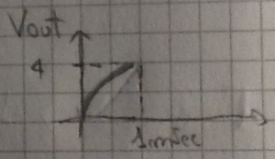
$V_{IN} = 0 \rightarrow V_{gs} = -V_S < V_T$ Transistor off →

Il condensatore per 1 mSec si carica:

$\tau = R_D \cdot C = 2\,10^3 \cdot 1 \cdot 10^{-6} = 2\,10^{-3} = 2$ mSec non si carica istantaneamente

$V_C(t) = V(\infty) - (V(\infty) - V(0))\, e^{-\frac{t}{\tau}} = 10 - 10\, e^{-\frac{t}{\tau}} = 10 - 10\, e^{-\frac{1\,10^{-3}}{2\,10^{-3}}} \approx 4V$

t: 1mSec
τ: 2mSec



$V_{IN} = 5V$

$V_{GS} = V_G - V_S > 1$ (Lo 5V) $\rightarrow V_S = IR_S$

$$\begin{cases} V_{gs} = 5 - I \\ I = K(V_{gs} - 1)^2 \end{cases} \rightarrow V_{gs} = 5 - 0,5\,(V_{gs} - 1)^2$$

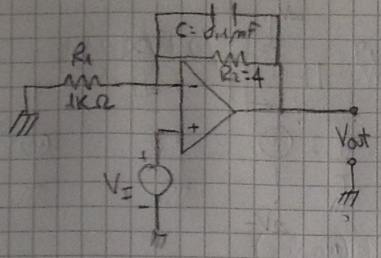
$\rightarrow V_{gs} = 5 - 0,5\,(V_{gs}^2 + 1 - 2V_{gs}) \rightarrow 2V_{gs} = 10 - V_{gs}^2 - 1 + 2V_{gs}$

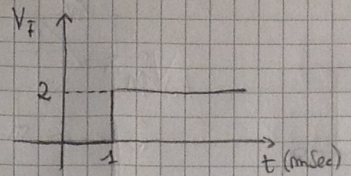
$+V_{gs}^2 = +9$ → $V_{GS} = -3$ / $V_{GS} = 3 > 1$ OK! $I = 2mA$

$V_{DS} \geq V_{GS} - V_T = 2$

$V_D - V_S = V_C - I \cdot R_S = 4 - 2 = 2$ OK! (più passa il tempo e più V_D aumenta quindi rimane sempre in zona lineare)

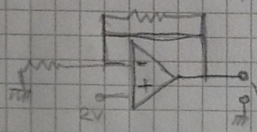
7/5/2011





$R_2 = 4K\Omega$
$R_1 = 1K\Omega$
$C = 0{,}1\,\mu F$

- quando $V_I = 0 \Rightarrow V_{out} = 0$
- quando $V_I = 2$ (con $t \to \infty$) $\Rightarrow V_{out} = V_I \cdot \left(1 + \frac{R_2}{R_1}\right) = 10$
  (perché il condensatore si è caricato tutto e diventa un circuito aperto)
- quando V_I sale da 0 a 2 (sul gradino) il condensatore si comporta da "circuito chiuso" e l'amplificatore funziona da inseguitore di tensione



la resistenza sul ramo di contro-reazione è come se non ci fosse

quindi $V_{out} = V_{in} = 2$

$$V_{out} = -V_C(t) = -\left(V_{(\infty)} - \left(V_{(0)} - V_{(\infty)}\right) e^{-t/\tau}\right) = -\left(\overbrace{-10 + 8\, e^{-t/\tau}}^{V_C}\right) = 10 - 8\, e^{-t/\tau}$$

$V_{(\infty)} = -10$, $V_{(0)} = -10$, $V_{(\infty)} = 2$