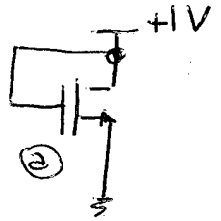
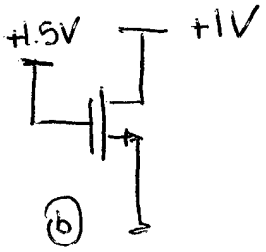
1ª PROVA - RECUPERO

(A) $V_T = 1.2V$ $\quad k = \frac{1}{2}\mu_n C_{ox}\frac{W}{L} = 3mA/V^2$



$V_{GS} = 1V < V_T \Rightarrow$ MOSFET INTERDETTO

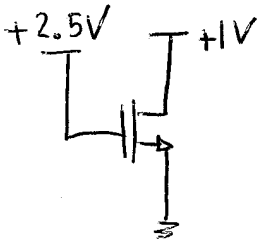
$I_D = 0$



$V_{GS} = 1.5V > V_T \Rightarrow$ MOSFET "ACCESO"

$V_{GD} = 0.5V < V_T \Rightarrow$ MOSFET IN SATURAZIONE

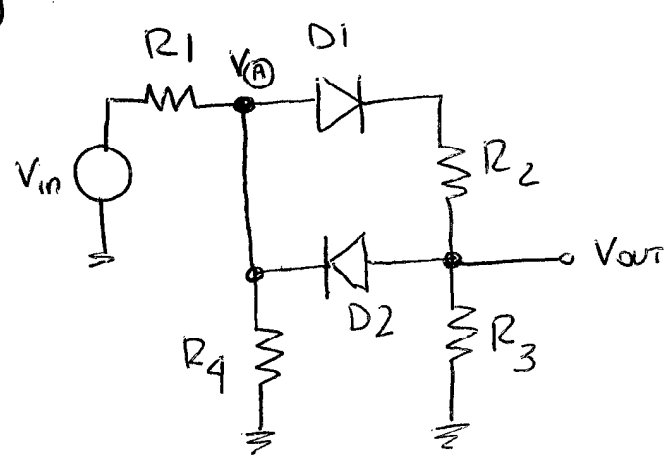
$I_D = k(V_{GS}-V_T)^2 = 3mA/V^2 * (1.5V - 1.2V)^2 = 270\mu A$



$V_{GS} = 2.5V > V_T \Rightarrow$ MOSFET "ACCESO"

$V_{GD} = 1.5V > V_T \Rightarrow$ MOSFET IN ZONA OHMICA

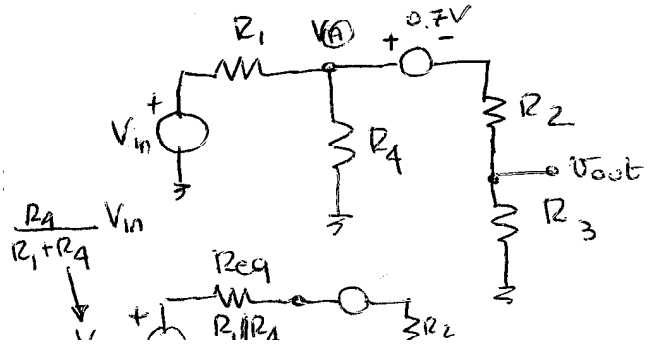
(B)



- semionda positiva

$V_{in} < 1.4V \Rightarrow V_A < 0.7V \Rightarrow D_1$ OFF, D_2 OFF $\Rightarrow V_{OUT} = 0$

$V_{in} \geq 1.4V \Rightarrow V_A > 0.7V \Rightarrow D_1$ ON, D_2 OFF



$$V_{picco} = (V_{eq} - 0.7V)\cdot\frac{R_3}{R_2 + R_3 + R_1 \| R_4} =$$

$$= \left(\frac{R_4}{R_1+R_4}V_{in} - 0.7V\right)\cdot\frac{R_3}{R_2+R_3+R_1\|R_4}$$

$$\sim (1\,V_{in} - 0.7V)\cdot\frac{1}{2} = 0.9V$$

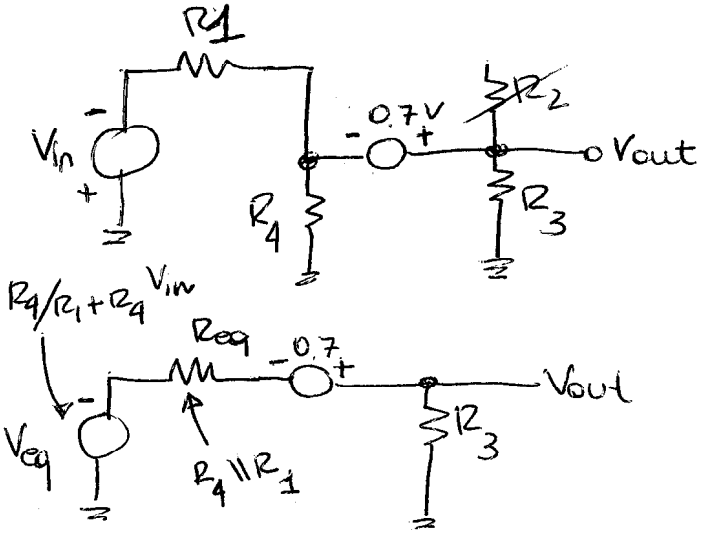
- semionda negativa

$V_A \geq -0.7V \Rightarrow D_2$ OFF, D_1 OFF

$\Downarrow$

$V_{in} > -1.4V$

$V_{in} \leq -1.4V \Rightarrow V_A < -0.7V \Rightarrow D_1$ OFF, D_2 ON

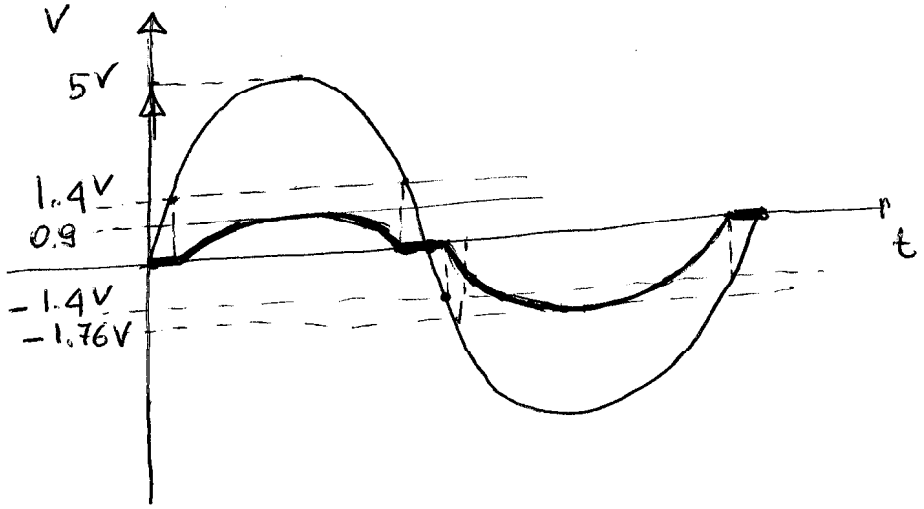


$$V_{picco} = (V_{eq} + 0.7V) \cdot \frac{R_3}{R_3 + R_{eq}}$$

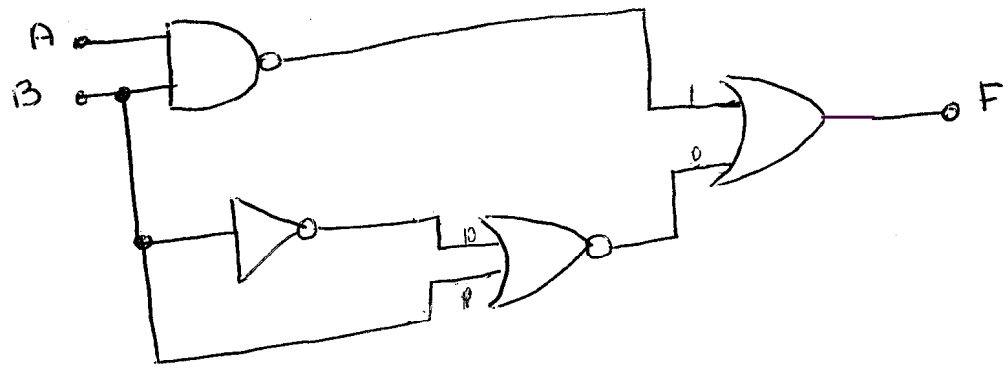
$$= \left(\frac{R_4}{R_1 + R_4} V_{in} + 0.7V\right) \frac{R_3}{R_3 + R_{eq}}$$

$$= \left(\frac{1}{2} V_{in} + 0.7V\right) \frac{20k}{20k + 0.5}$$

$$= -1.76V$$



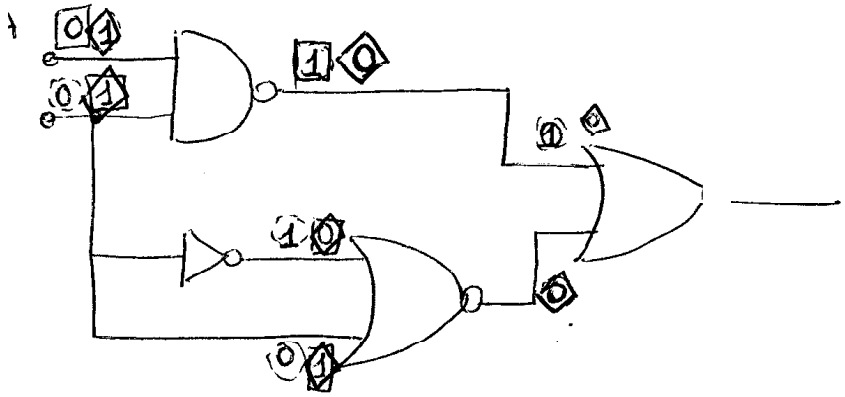
(c)

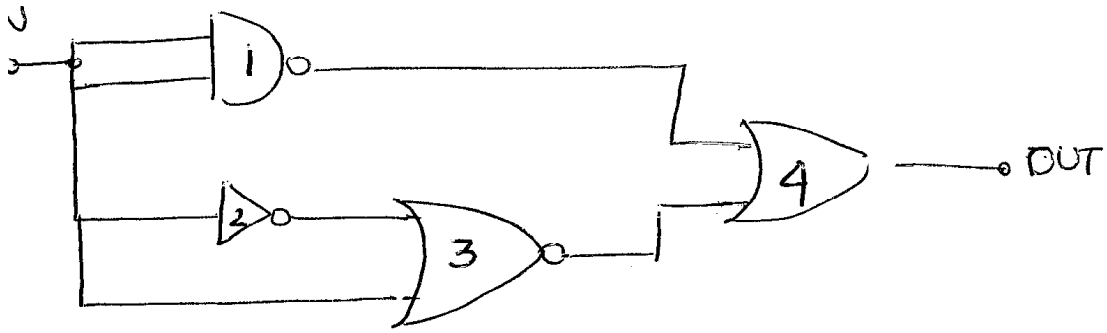


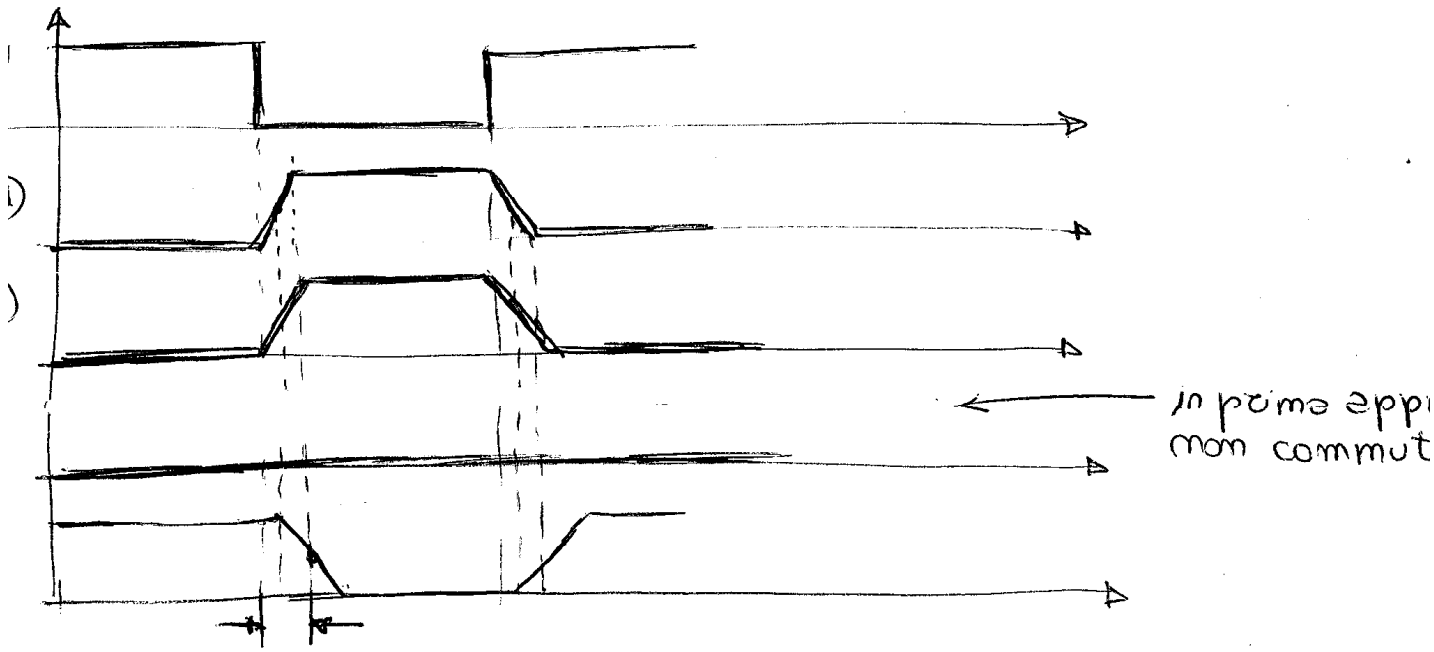
A	B	F
0	0	1
0	1	1
1	0	1
1	1	0

$\Rightarrow F = \overline{A \cdot B}$

$F = \overline{(A \cdot B)} + (\overline{B} + B) =$







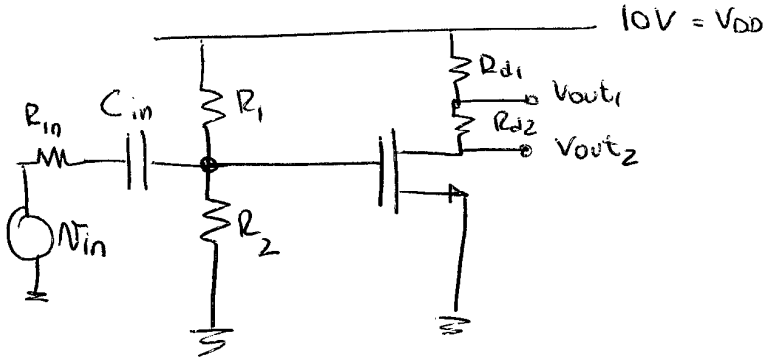
$\tau_D = 2t_p = 40ns$

$P_1 = C V_{DD}^2 f = C_{in} V_{DD}^2 f = 2pF * (5V)^2 * 1MHz = 50\mu W$

$P_2 = C V_{DD}^2 f = C_{in} V_{DD}^2 f = 50\mu W$

$P_3 = 0$ poichè non commuta

(D)



(1) $V_G = \frac{R_2}{R_1+R_2} \cdot V_{DD} = 10V \times \frac{20k}{20k+80k} = 2V$

$V_{GS} = +2V \Rightarrow I_D = k(V_{GS}-V_T)^2 = 1mA/V^2 (2V-1V)^2 = 1mA$

$V_{out_2} = 10V - 1mA(R_{d1}+R_{d2}) = 3V$

$V_{out_1} = 10V - 1mA\ R_{d1} = 8V$

$I_{div} = \frac{10V}{100k} = 100\mu A$

$V_{GD} = 2V - 3V = -1V < V_T$ ok MOS astuto

$g_m = \frac{\partial I_D}{\partial V_{GS}} = 2k(V_{GS}-V_T) = 2\ mA/V$

(2) $\frac{V_{out_2}}{V_{in}} = -\frac{R_2 \| R_1}{R_{in}+R_2\|R_1} \cdot g_m (R_{d1}+R_{d2}) = \frac{-16k}{16k+1k} \cdot 2mA/V \cdot 7k\Omega =$

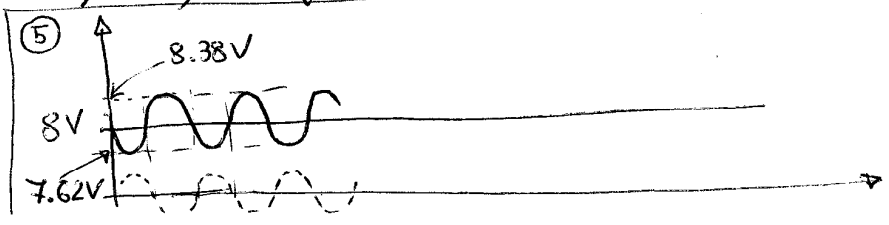
$= -13.2$

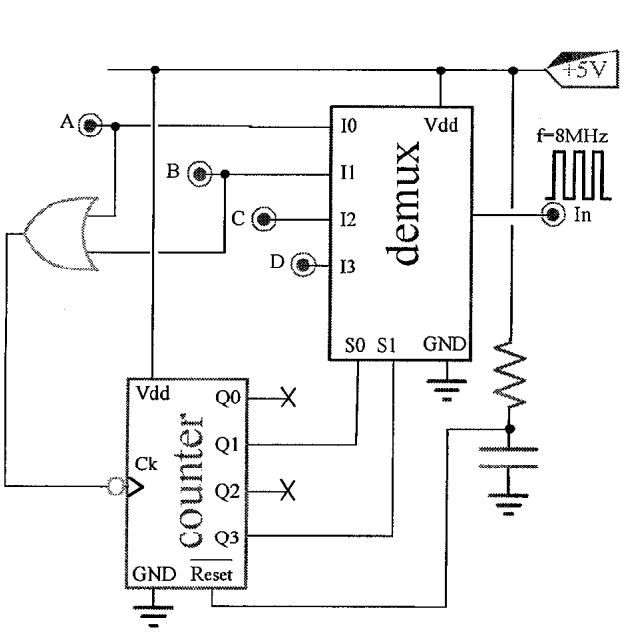
(3) $\frac{V_{out\,1}}{V_{in}} = -\frac{R_2\|R_1}{R_{in}+R_2\|R_1} g_m R_{d1} = -\frac{16k}{17k} \cdot 2mA/V \cdot 2k\Omega = -3.8$

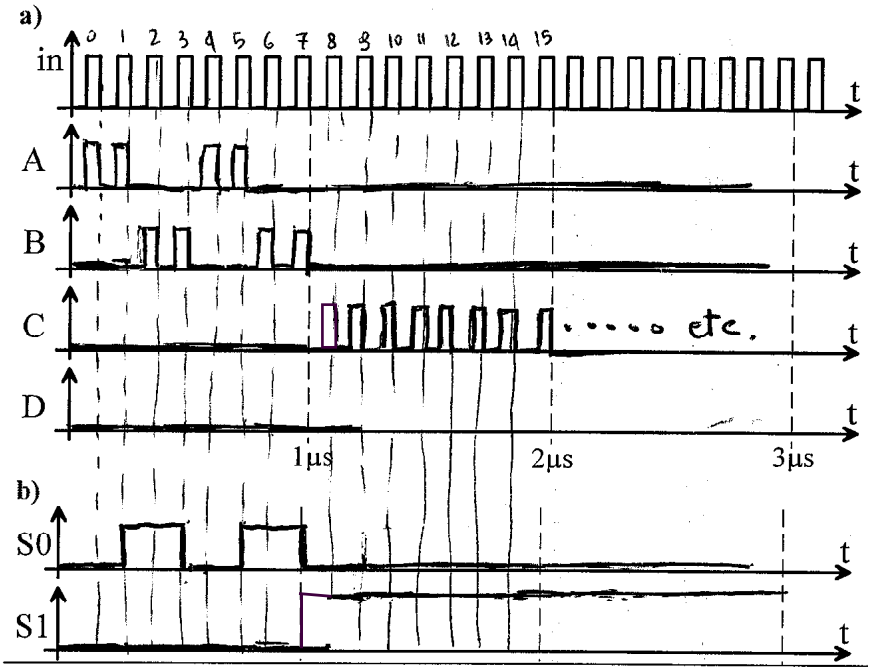
(4) C_{in} introduce uno zero nell'origine e un polo con costante di tempo $\tau = C_{in}(R_{in}+R_1\|R_2) = 1\mu F \times (1k+16k) = 17ms$

$\Rightarrow f_p = \frac{1}{2\pi\tau} = 9.4\ Hz$

(5)




+5V
A
B
C
D
I0
I1
I2
I3
Vdd
demux
S0 S1
GND
f=8MHz
In
Vdd
Q0
Q1
Q2
Q3
Ck
counter
GND
Reset


a)
in
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
t
A
B
C
D
..... etc.
1µs
2µs
3µs
b)
S0
S1