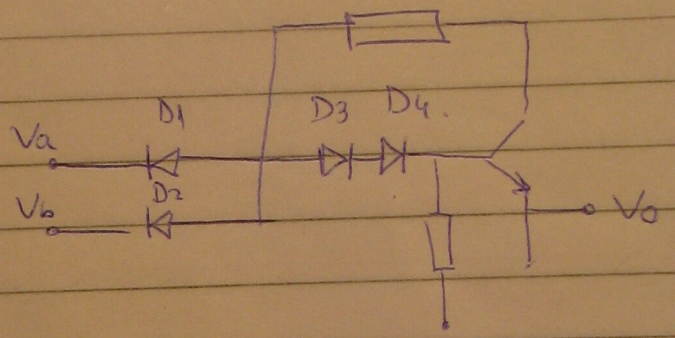
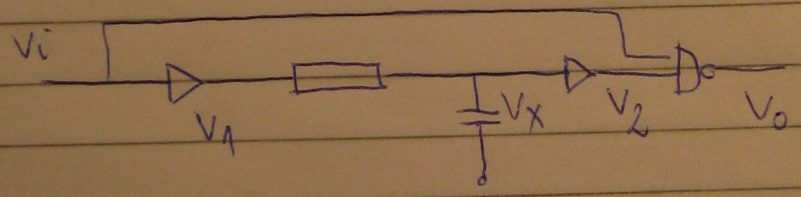
SUBIECT G

1. Circuitul TTL de bază
   a) Funcționare pt $V_i = V_L = 0,2V$
   b) -"- $V_i = V_H = 3,5V$
   c) Puterea statică.

2. Circuite logice cu diode și tranzistoare
   a) funcționare
   b) dimensionare / construcție
   c) $V_0 = ?$ $V_i = 0,2V$ $V_{EE} = -2V$, $\beta = 200$
   $V_H = 3,5V$



3.

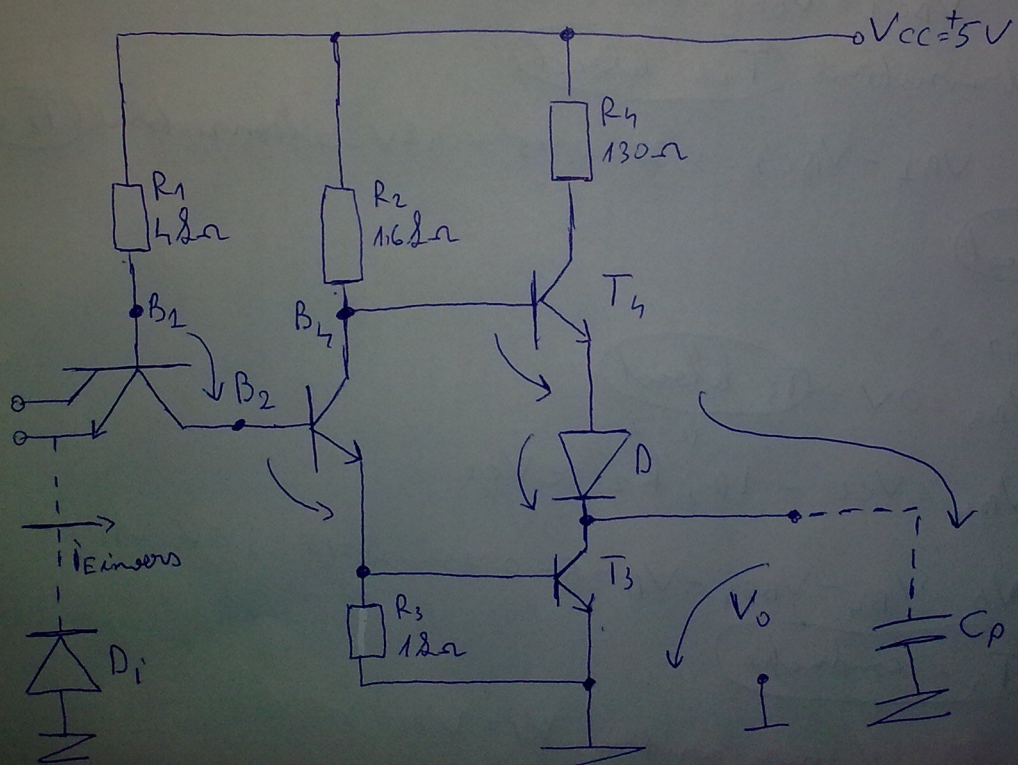


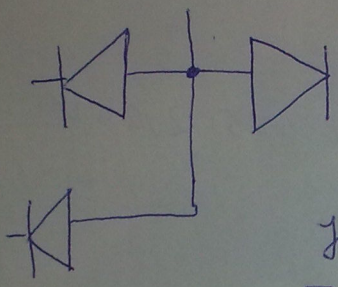
   a) Diag de timp pt V_i, V_1, V_x, V_2, V_0
   b) Calculul timpilor pt ieșire
   $R = 0,3k\Omega$ $C = 3nF$ $V_T = 1,5V$
   $V_L = 0,2V$ $V_H = 3,5V$

G

1 Circuitul de bază TTL

a) Funcționare pentru $V_i = V_L = 0,2V$





Tranzistor multiemitor

D_i - are rol protector.

Jonctiunea BE poarta rolul unei trepte de tensiune

T_2 = tranzistor de comanda de la poarta cu diode si tranzistoare.

- Imbunatatirea timpului de propagare => Imbunatatirea puterii comandate.
- Push - pull { t_p scade / P_{cc} creste

$V_A = V_B = V_L = 0,2V$

$V_{B1} = V_L + V_{BE1} = 0,2 + 0,75 = 0,95V$

$(V_{B1} = V_{BC1} = V_{BE2} = 0,65 + 0,65 = 1,3V)$

$\Rightarrow$ tranzistorul (T_1 e blocat)

$V_{B2} = V_{B1} - V_{BC1} = 0,95 - 0,75 = 0,2V \Rightarrow$ tranzistorul (T_2 e blocat)

$i_{E2} = 0$

$V_{B3} = 0V \Rightarrow$ (T_3 blocat)

$i = i_C = 0$

$V_{B4} = V_{CC} - i_{R_2} R_2 \approx V_{CC}$

$V_0 = V_{B4} - V_{BE4} - V_D = 5 - 0,75 - 0,75 = 3,5V = V_H \Rightarrow$

(T_4 - conductie)

b) Funcționare pentru $V_i = V_{IH} = 3,5V$.

$V_A = V_B = V_{IH} = 3,5$

$V_{B1} \nearrow V_{CC}$

$V_{B1} = V_{BE_3} + V_{BE_2} + V_{BC1} = 0,75 + 0,75 + 0,75 = 2,25V$

j_{BE_1} - polarizată invers

j_{BE_1} - polarizată direct

j_{BC_2} - polarizată direct

T_1 - saturat

$\Rightarrow j_{BE_1}$ - polarizată direct $\Rightarrow T_1$ lucrează în regim

invers -> FE mare.

$i_{E\ invers} = \beta_i \cdot i_{B_1}$; $\beta_i \in 0,5 \div 0,02$.

$V_{B1} = 2,25V$

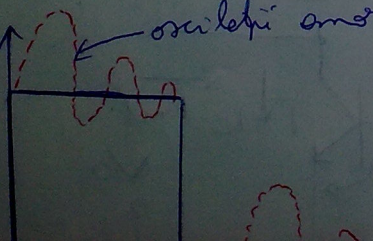
$V_{B2} = V_{B1} - V_{BC1} = 2,25 - 0,75 = 1,5V \rightarrow T_2$ - saturat.

$V_{B3} = V_{B2} - V_{BC2S} = 1,5 - 0,75 = 0,75V \rightarrow T_3$ saturat.

$V_o = V_{CES} \approx 0,2V$

$V_{B4} = V_{B3} + V_{CE3} = 0,75 + 0,2 = 0,95V \rightarrow T_4$ blocat.

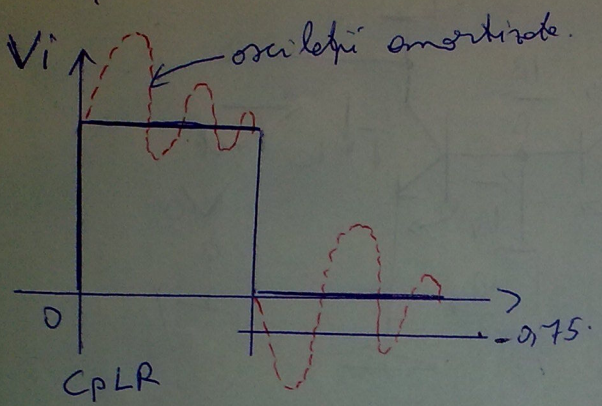
Vi



oscilații amortizate.

D_i - asigură creșterea frecvenței de lucru

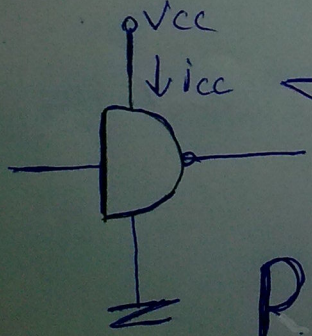
C_p - capacitate parazită.



D_i - origină creștere frecvență de lucru

C_p - capacitate parazită.

b) Putere statică.



I_{CCH} pentru $V_0 = V_H$

I_{CCL} pentru $V_0 = V_L$

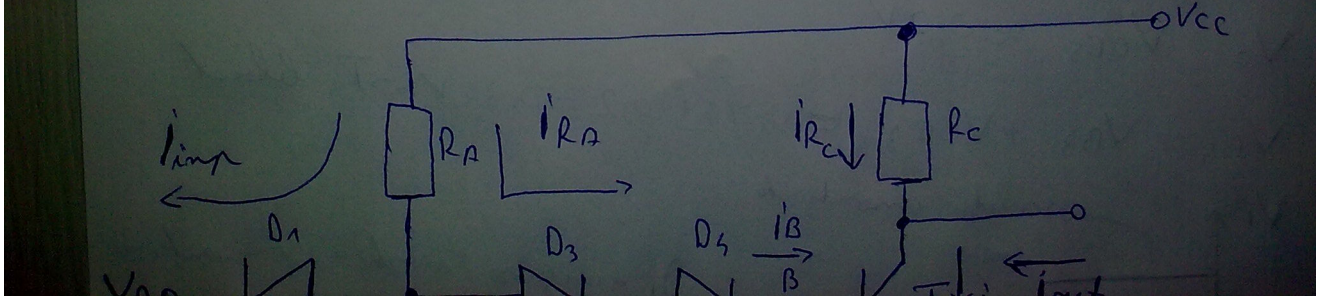
$$P_{cc} = \frac{I_{CCL} + I_{CCH}}{2} \cdot V_{cc} \quad [mW]$$

I_{CCH} - curentul absorbit de circuitul logic când la ieșire se obține nivelul superior de tensiune.

I_{CCL} - curentul absorbit de circuitul logic când la ieșire se obține nivelul inferior de tensiune.

2. Circuite logice cu diode și tranzistoare.

a) Funcționare.



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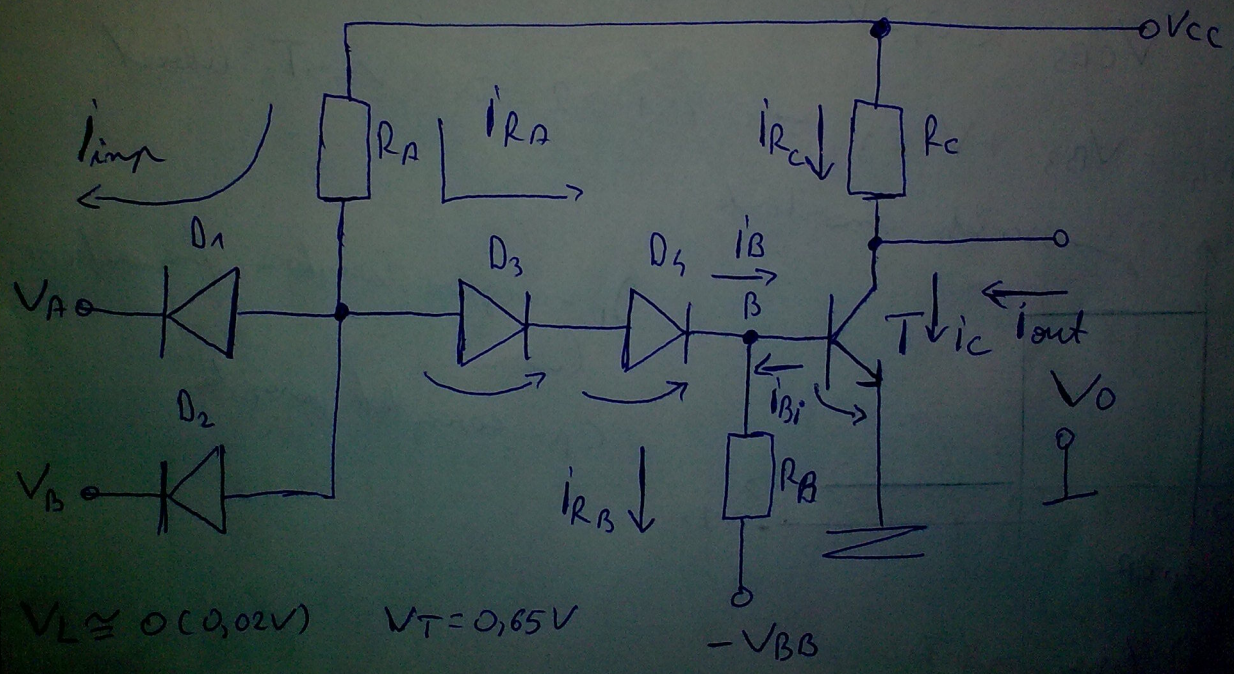
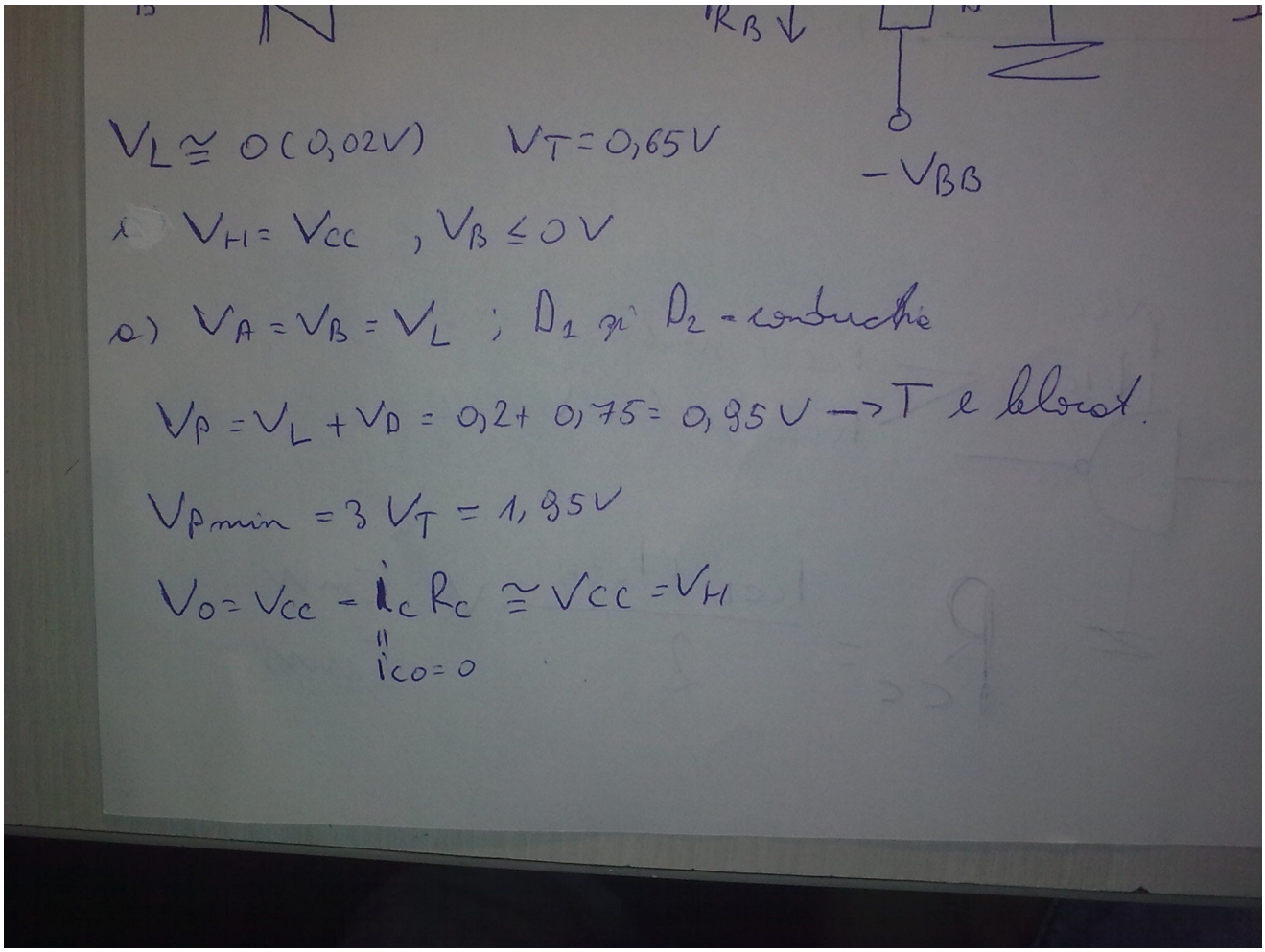
a) Funcționare.



$V_L \cong 0 (0,02V)$ $V_T = 0,65V$

$V_H = V_{CC}$, $V_B \leq 0V$


$R_B \downarrow$
$-V_{BB}$
$V_L \cong 0 (0,02V)$ $V_T = 0,65V$
$V_{H1} = V_{CC}$, $V_B \leq 0V$
a) $V_A = V_B = V_L$; D_1 și D_2 - conductie
$V_P = V_L + V_D = 0,2 + 0,75 = 0,95V$ -> T e blocat.
$V_{P\,min} = 3 V_T = 1,95V$
$V_0 = V_{CC} - i_C R_C \cong V_{CC} = V_H$
$i_C = i_{CO} = 0$

c) $V_A = V_L$; $V_B = V_{H1}$

$V_A = V_H$; $V_B = V_L$ $\Rightarrow V_0 = V_{CC} = V_H$

d) $V_A = V_B = V_{H1}$; D_1, D_2 - blocate.

$V_p \nearrow V_{CC}$

$V_p = V_{D_3} + V_{D_4} + V_{BE} = 0,75 + 0,75 + 0,75 = 2,25V$

D_1 și D_2 polarizate invers.

$\Rightarrow D_3$, D_4, T - conductie

$V_0 = V_{CES} = 0,2V = V_L$

V_A	V_B	V_0
V_L	V_L	V_H

A	B	F
0	0	1

D_1 și D_2 polarizate invers.

$\Rightarrow D_3, R_{4}, T$ - conductie

$V_0 = V_{CES} = 0,2V = V_L$

V_A	V_B	V_0
V_L	V_L	V_H
V_L	V_H	V_H
V_H	V_L	V_H
V_H	V_H	V_L

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

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

V_H	V_H	V_L	1	1	0

le) Dimensionare / construcție.

a) R_C - limitează curentul prin tranzistor

i_{out} - curent, T - saturat

$i_{out} = i_C - i_{R_C}$

i_C - curentul pe care îl dorim

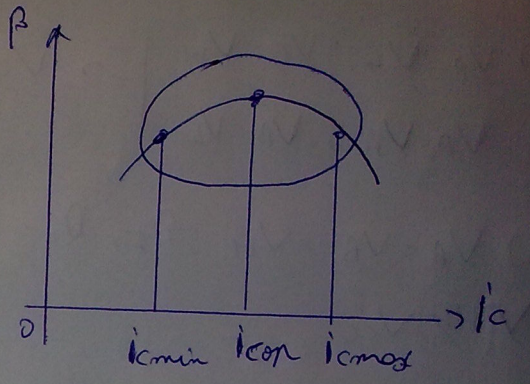
- se alege rezistorul β e minim.

$P = i \cdot V$ (mică) (i_{cmin})

R_C - mare.

R_C - mic

$P = i \cdot V$ mare (i_{cmax})



$i_{cop} = i_{out} + i_{R_C}$

$$R_C = \frac{V_{CC} - V_{CES}}{i_{R_C}}$$

Exemplu: $i_{out} = 5mA$; $i_{cop} = 10mA$; $V_{CC} = 5V$.

$$R_C = \frac{5 - 0,2}{5 \cdot 10^{-3}} = 1 k\Omega.$$

b) R_B - T -> blocat.

$$i_{Bi} = \frac{V_{BE} + V_{BB}}{R_B} \Rightarrow V_{BE} \leq 0$$

b) R_B - T -> blocat.

$$i_{Bi} = \frac{V_{BE} + V_{BB}}{R_B} \Rightarrow V_{BE} \leq 0$$

$$i_{Bi} \cdot R_B = V_{BE} + V_{BB} \leq 0$$

$$R_B \leq \frac{V_{BB}}{i_{Bi}} = \frac{V_{BB}}{i_{CO}}$$

- cazul cu infinitate de soluții

$$i_{Bi} = i_{CO}$$

Exemplu: $V_{BB} = -2V$; $i_{CO} = 50\mu A$

$$R_B = \frac{2}{50 \cdot 10^{-6}} = 40 \cdot 10^3 = 40k\Omega$$

c) R_A -> pentru T - saturat.

$$i_{RA} = i_B + i_{RB} \; ; \; i_B \cdot \beta \geq i_C$$

$$i_B = i_{RA} - i_{RB}$$

$$i_{RA} = \frac{V_{CC} - V_P}{R_A} \quad V_P = 2{,}25$$

$$i_{RP} = 2{,}25\,V$$

$$i_{RB} = \frac{V_{BES} + V_{BB}}{R_B}$$

$$i_B = \frac{V_{CC} - 2{,}25}{R_A} - \frac{0{,}75 + V_{BB}}{R_B} \geq \frac{i_C}{\beta}$$

$$R_A \leq \frac{V_{CC} - 2{,}25}{\frac{i_C}{\beta} + \frac{0{,}75 + V_{BB}}{R_B}}$$

Exemplu: $\beta = 20$, $V_{BB} = -2\,V$; $R_B = 40\,k\Omega$; $i_C = 10\,mA$.

$$R_A \leq \frac{5 - 2{,}25}{\frac{10 \cdot 10^{-3}}{20} + \frac{0{,}75 + 2}{40 \cdot 10^3}} = \frac{2{,}75}{(0{,}5 + 0{,}07) \cdot 10^{-3}} = \frac{2{,}75}{0{,}57} \cdot 10^3 =$$

Exemplu: $\beta = 20$, $V_{BB} = -2V$; $R_B = 40 k\Omega$; $i_C = 10 mA$.

$$R_A \leq \frac{5 - 2,25}{\frac{10 \cdot 10^{-3}}{20} + \frac{0,75+2}{40 \cdot 10^3}} = \frac{2,75}{(0,5+0,07) \cdot 10^{-3}} = \frac{2,75}{0,57} \cdot 10^3 =$$

$$= 4,3 k\Omega$$

Verificare: rate?

$$N = \frac{i_{out}}{i_{inp}}$$

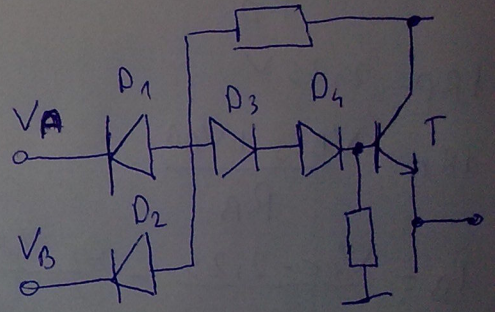
$$i_{inp} = \frac{V_{CC} - V_P}{R_A} = \frac{5 - 0,45}{4,3 \cdot 10^3} = \frac{4,05}{4,3 \cdot 10^3} = 0,9 mA.$$

$$N = \frac{5}{0,9} = 5 \text{ (valoare întreagă).}$$

c) $V_o = ?$; $V_i = 0,2V$, $V_{EE} = -2V$, $\beta = 200$, $V_{H1} = 3,5V$

$$V_o = V_{cc} - i_c R_c$$

$$i_c \approx 0 \Rightarrow V_o = V_{cc}$$



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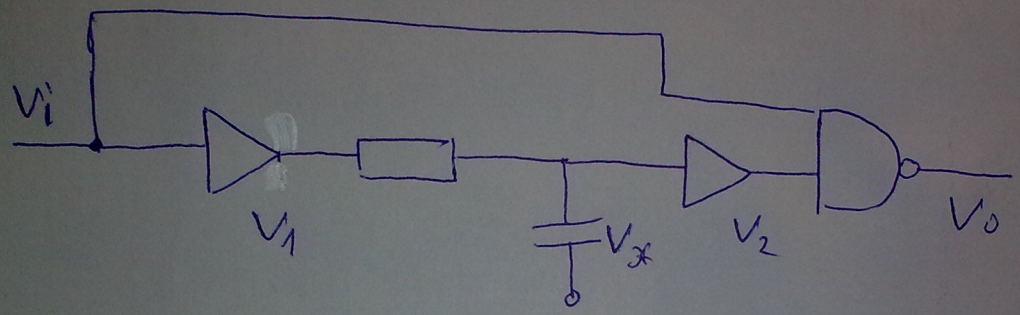
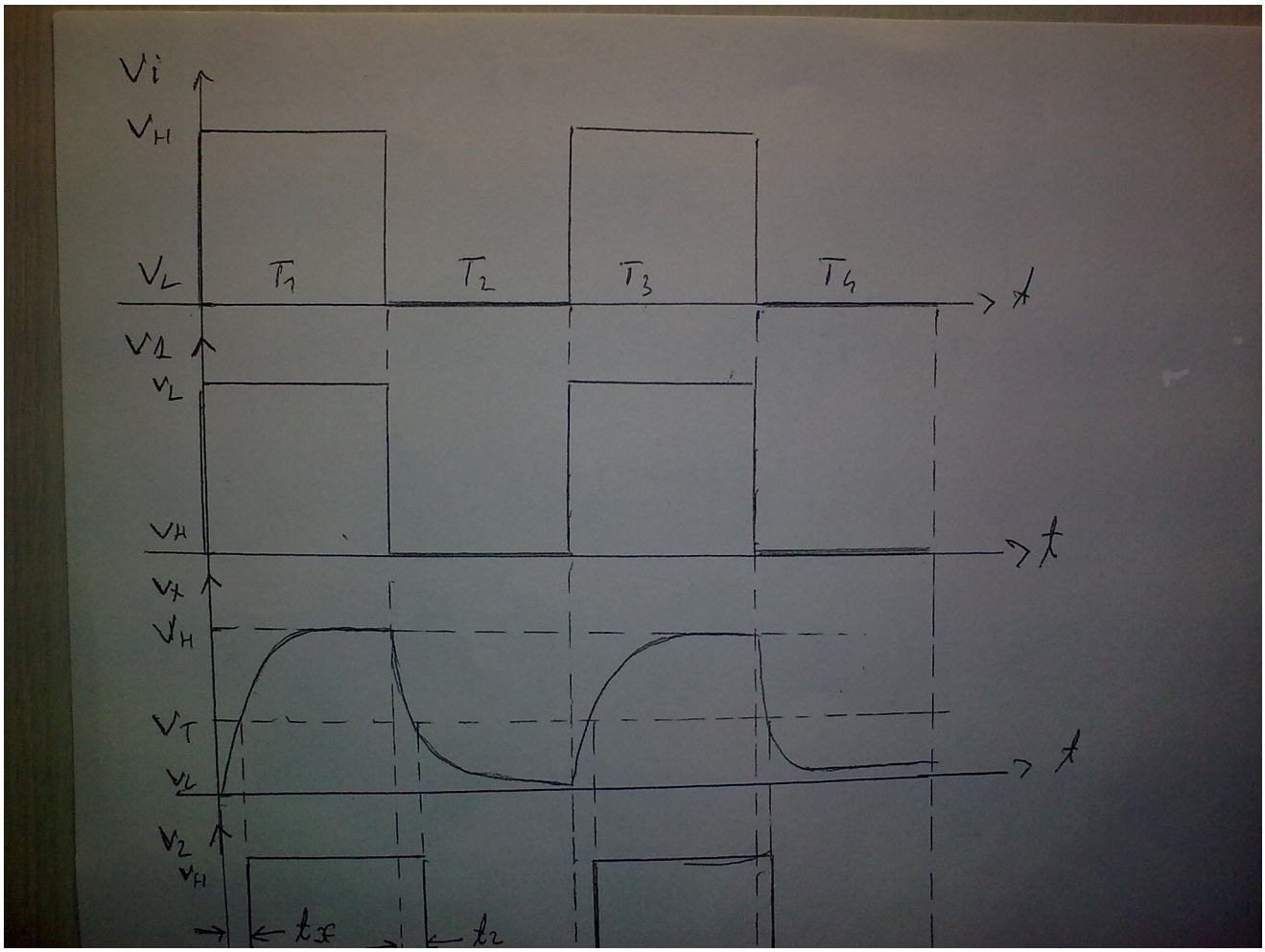


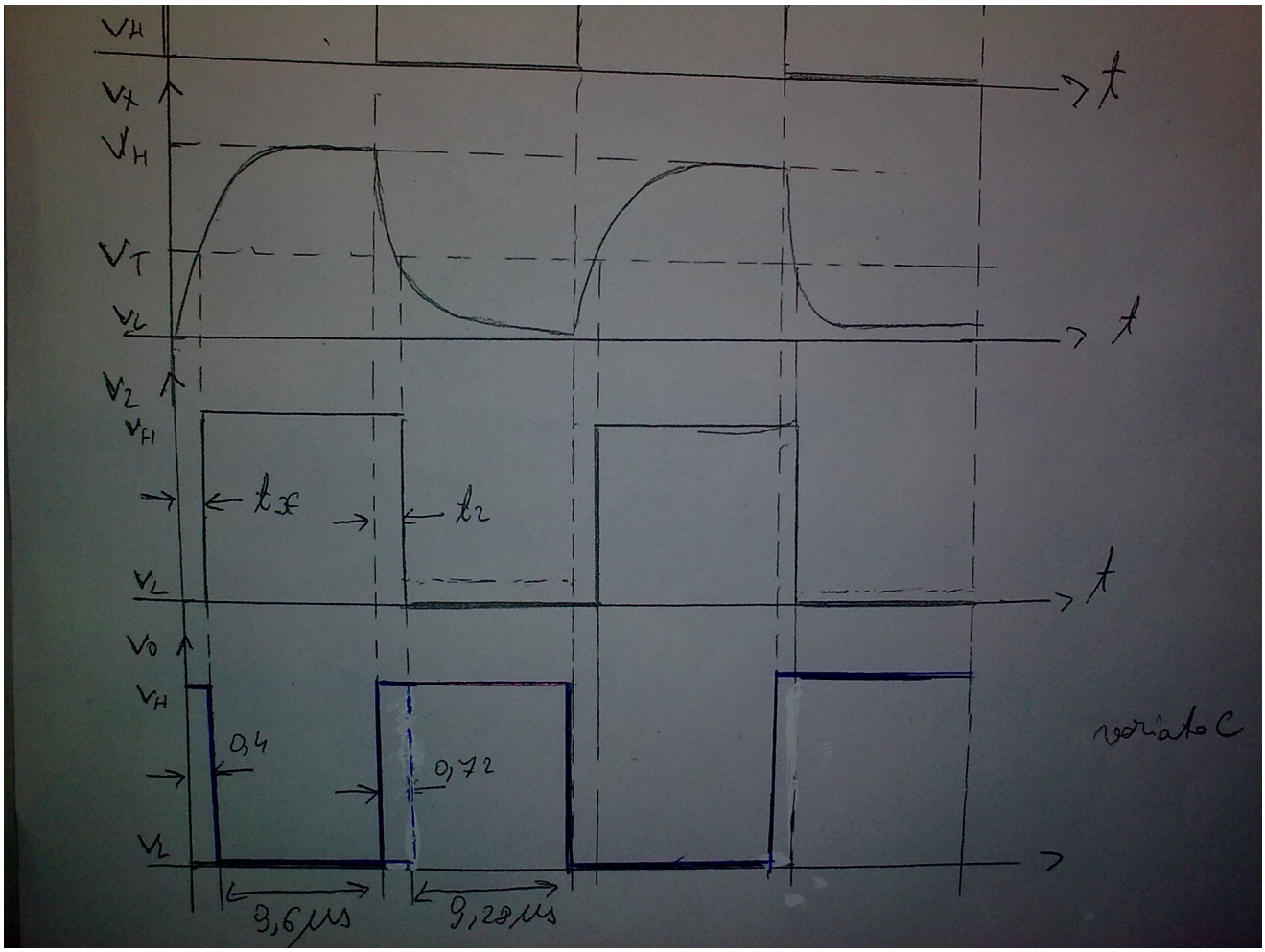
a) Diagrama de timp pentru V_i, V_1, V_x, V_2 V_0

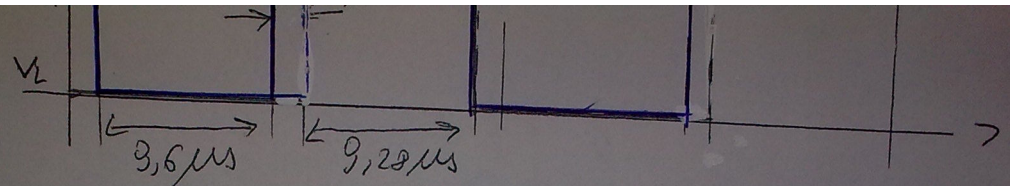
b) Calculul timpilor de ieșire.

$R = 0{,}3\ k\Omega$ $\quad C = 3\ nF$ $\quad V_T = 1{,}5V$.

$V_L = 0{,}2V$ $\quad V_{H1} = 3{,}5V$


Vi
VH
VL
T1
T2
T3
T4
t
VL
VH
t
VH
VT
VL
t
V2
VH
tx
t2


V_H
V_T
V_H
V_T
V_L
t
t
V_2
V_H
t_x
t_2
V_L
t
V_0
V_H
0,4
0,72
V_L
3,6 µs
9,28 µs
variato C



$$t_x = RC \ln \frac{V_H - 0,1V}{V_H - V_T} = 0,3 \cdot 10^3 \cdot 3 \cdot 10^{-9} \ln \frac{3,5 - 0,1 \cdot 3,5}{3,5 - 1,5} =$$

$$= 0,4\ \mu s.$$

$$t_2 = RC \ln \frac{V_L - 0{,}9V}{V_L - V_T} = 0{,}3 \cdot 10^3 \cdot 3 \cdot 10^{-9} \ln \frac{0{,}2 - 0{,}9 \cdot 3{,}5}{0{,}2 - 1{,}5} =$$

$$= 0{,}72\,\mu s$$

$$T_1 = 0{,}4 + 9{,}6 + 0{,}72 = 10{,}72\,\mu s$$

$$T_2 = 9{,}28\,\mu s.$$