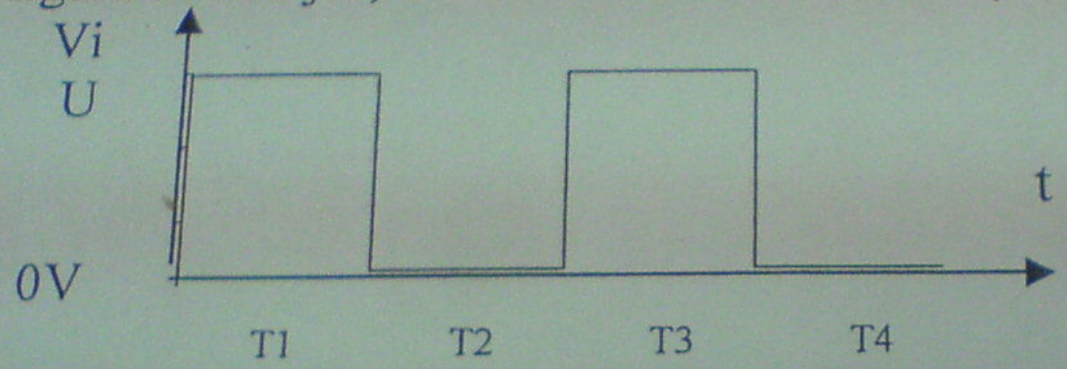
A1 a). Răspunsul circuitului RC trece-sus la un semnal impuls repetitiv: diagrama de timp, e
matematică;

b). Să se determine răspunsul circuitului RC trece-sus la intrarea căruia se aplică semn
figura de mai jos, unde: T1=T2=T3=T4= 100μs, R= 10KΩ, C= 10nF, U=5V.

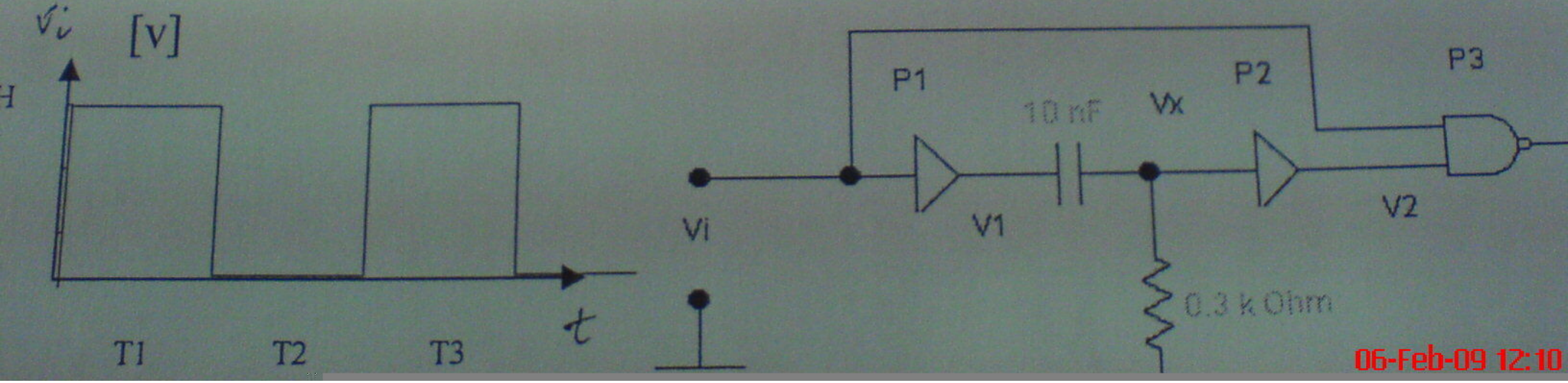


A2 a). Caracteristica statică de transfer la circuitele integrate TTL;

b). Definirea nivelelor logice de la intrare pe baza caracteristicii;

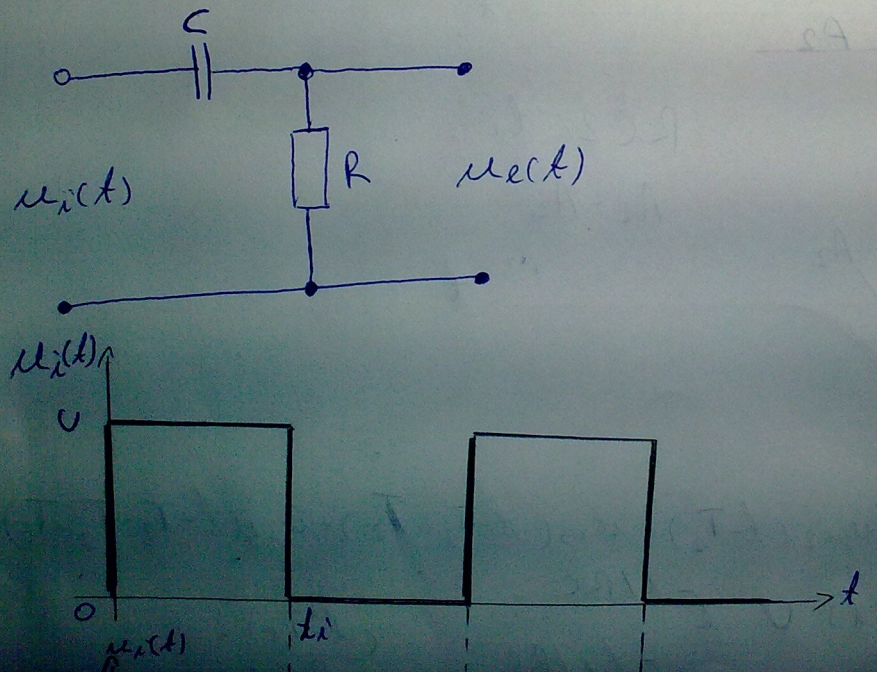
c). Definirea nivelelor logice de la ieşire pe baza caracteristicii.

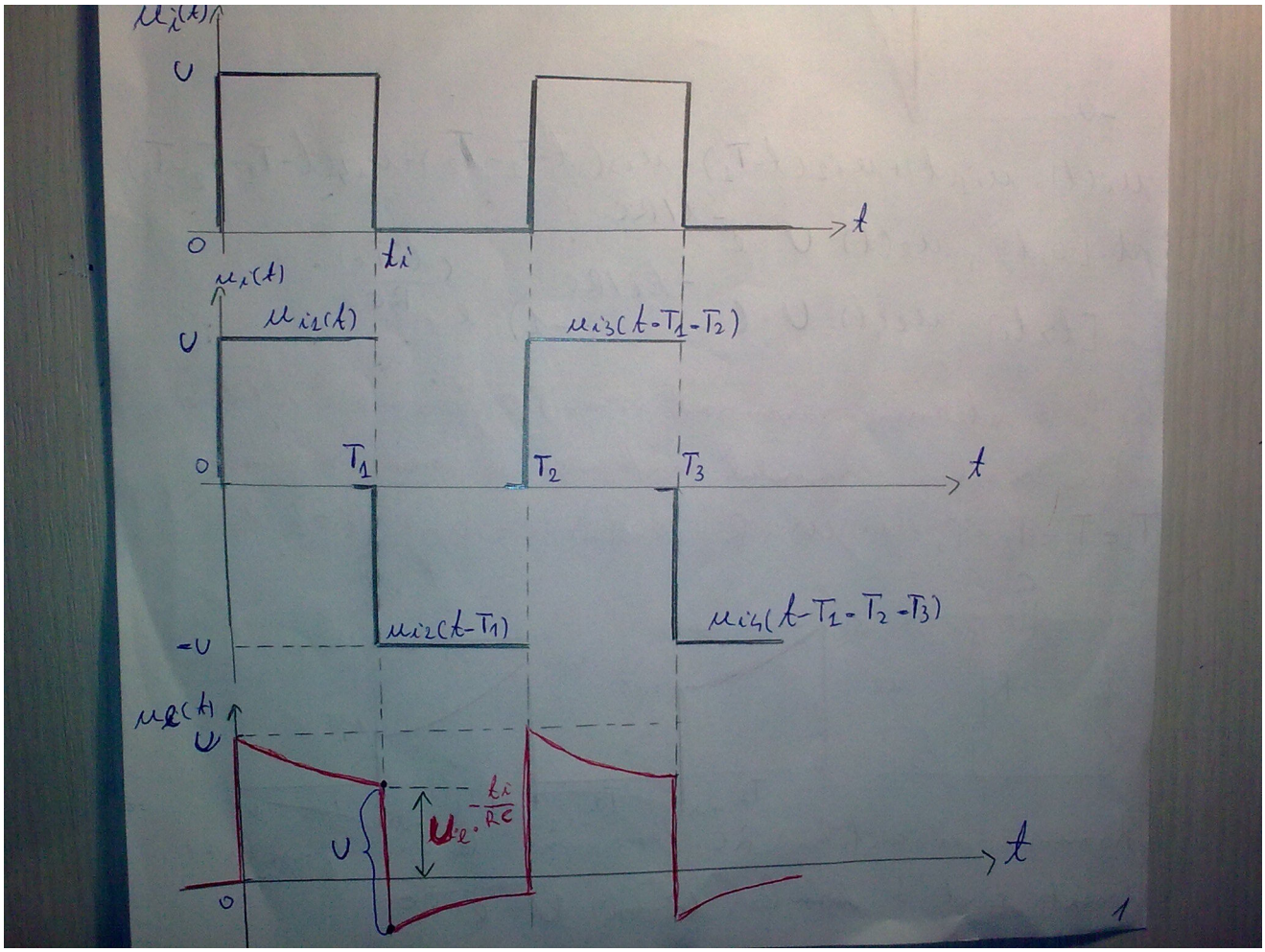
A3. Se dă circuitul din figura de mai jos la intrarea căruia se aplică semnalul din figură., se

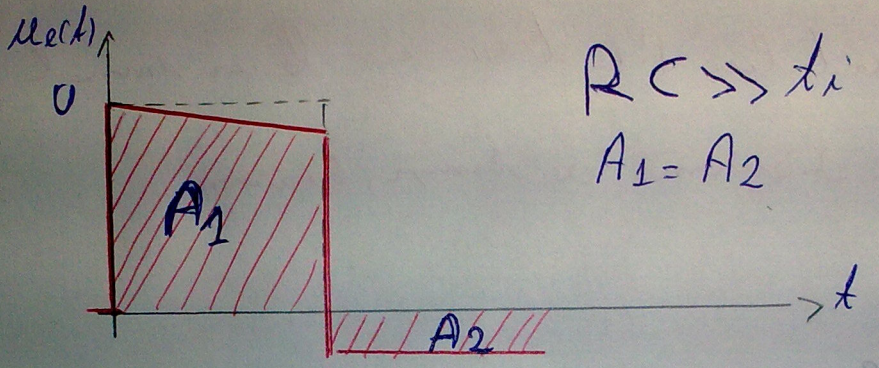


A.

1. a) Răspunsul circuitului RC trece-sus la un semnal impuls repetitiv: diagrama de timp, expresia matematică.

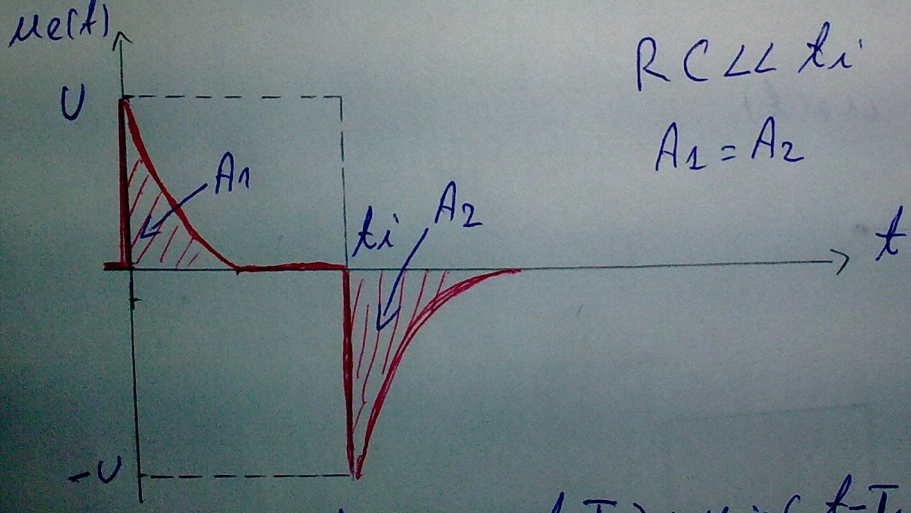



$u_i(t)$
U
0
t_i
t
$u_i(t)$
$u_{i2}(t)$
$u_{i3}(t-T_1-T_2)$
U
0
T_1
T_2
T_3
t
-U
$u_{i2}(t-T_1)$
$u_{i4}(t-T_2-T_2-T_3)$
$u_2(t)$
U
U
$U_{2e}\cdot e^{-\frac{t_i}{RC}}$
t
0
1



$RC \gg t_i$

$A_1 = A_2$



$RC \ll t_i$

$A_1 = A_2$

$u_{i1}(t) + u_{i2}(t - T_1) + u_{i3}(t - T_1 - T_2) + u_{i4}(t - T_1$

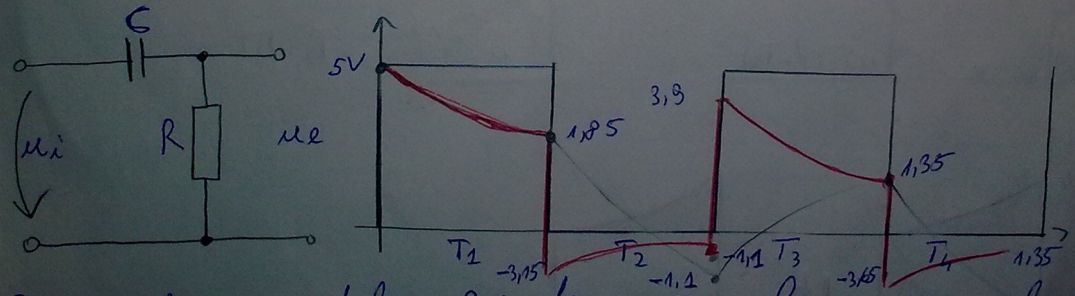
$u_i(t) = u_{i1}(t) + u_{i2}(t-T_1) + u_{i3}(t-T_1-T_2) + u_{i4}(t-T_1-T_2-T_3)$

pt. $[0, t_i]$, $u_e(t) = U \cdot e^{-t/RC}$

$[t > t_i]$, $u_e(t) = U \cdot (e^{-t_i/RC} - 1) \cdot e^{\frac{(t-T_i)}{RC}}$

b) Să se determine răspunsul unui RC trece sus la intrare unui semnal dreptunghiular din figura de mai jos, unde:

$T_1 = T_2 = T_3 = T_4 = 100\mu s$; $R = 10 k\Omega$; $C = 10 nF$; $U = 5V$



Răspunsul circuitului RC trece sus la un semnal dreptunghiular este dat de formula: $u_e(t) = U \cdot e^{-\frac{t}{RC}}$

=> a) pentru $t=0 \Rightarrow u_e(0) = U = 5V$

b) $t \in [0, T_1) \Rightarrow u_e(t) = U \cdot e^{-\frac{t}{RC}}$

$t = T_1 \Rightarrow u_e(T_1) = U \cdot e^{-\frac{T_1}{RC}} = 5 \cdot e^{-\frac{100 \cdot 10^{-12}}{100 \cdot 10^3 \cdot 10^{-9}}} = 5 \cdot e^{-1} =$

$= 5 \cdot 0,37 = 1,85 V$

c) $t \in [T_1, T_1 + T_2]$

$u_e(t) = U \cdot e^{-\frac{t}{RC}} - U \cdot e^{-\frac{t - T_1}{RC}}$

$t = T_1 + T_2 \Rightarrow u_e(T_1 + T_2) = U \cdot e^{-\frac{T_1 + T_2}{RC}} - U \cdot e^{-\frac{T_2}{RC}} =$

$= U \cdot e^{-2} - U \cdot e^{-1} = U\left(\frac{1}{e^2} - \frac{1}{e}\right) = -1,1 V$

d) $t \in [T_1 + T_2, T_1 + T_2 + T_3]$

$u_e(t) = U \cdot e^{-\frac{t}{RC}} - U \cdot e^{-\frac{t - T_1}{RC}} + U \cdot e^{-\frac{t - T_1 - T_2}{RC}}$

$t = T_1 + T_2 + T_3 \Rightarrow u_e(T_1 + T_2 + T_3) = U \cdot e^{-\frac{T_1 + T_2 + T_3}{RC}} - U \cdot e^{-\frac{T_1 + T_2 + T_3 - T_1}{RC}} +$

$u_e(t) = U \cdot e^{-\frac{t}{RC}} - U \cdot e^{-\frac{t}{RC}} + U \cdot e^{-\frac{t}{RC}}$

$t = T_1 + T_2 + T_3 \Rightarrow u_e(T_1 + T_2 + T_3) = U \cdot e^{-\frac{T_1+T_2+T_3}{RC}} - U \cdot e^{-\frac{T_1+T_2+T_3-T_1}{RC}} +$

$+ U \cdot e^{-\frac{T_1+T_2+T_3-T_1-T_2}{RC}} = U \cdot e^{-3} - U \cdot e^{-2} + U \cdot e^{-1} =$

$= U \cdot 0{,}05 - U e^{-2} + U \cdot 0{,}37 = 1{,}35V$

b) $t \in [T_1+T_2+T_3, T_1+T_2+T_3+T_4]$

$u_e(t) = U \cdot e^{-t/RC} - U \cdot e^{-\frac{t-T_1}{RC}} + U \cdot e^{-\frac{t-T_1-T_2}{RC}} - U \cdot e^{-\frac{t-T_1-T_2-T_3}{RC}} =$

$t = T_1+T_2+T_3+T_4 \Rightarrow u_e(t) = U \cdot e^{-4} - U \cdot e^{-3} + U \cdot e^{-2} - U \cdot e^{-1} =$

$= U(e^{-4} - e^{-3} + e^{-2} - e^{-1}) = U(-0{,}05 + 0{,}15 - 0{,}37) =$

$= -1{,}35.$

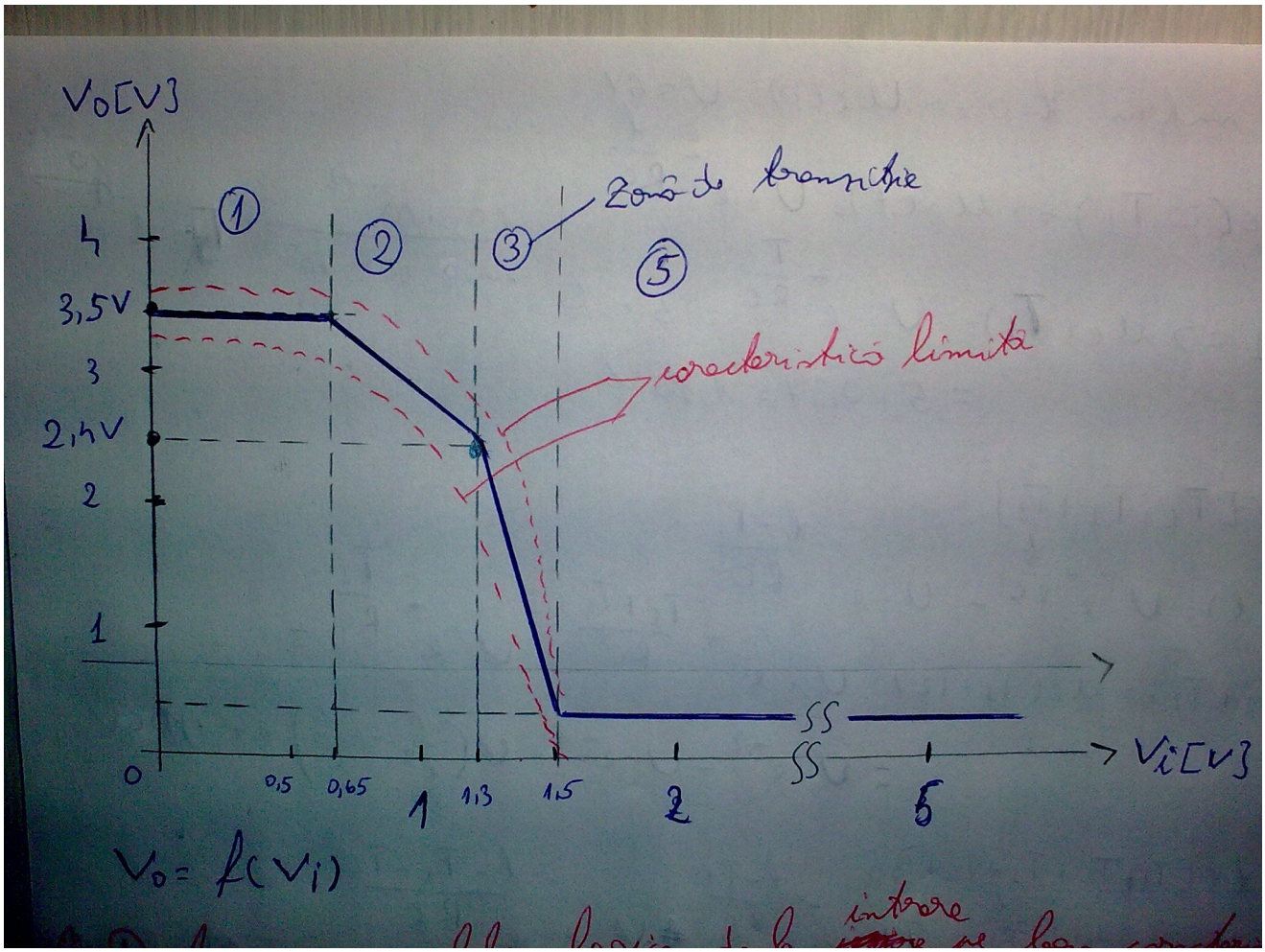
2. Caracteristica statică de transfer la circuitele integrate TTL.

$t = T_1 + T_2 + T_3 + T_4 \Rightarrow u_e(t) = U \cdot e^{-4} - U \cdot e^{-3} + U \cdot e^{-2} - U \cdot e^{-1} =$

$= U(e^{-4} + e^{-3} + e^{-2} - e^{-1}) = U(-0,05 + 0,15 - 0,37) =$

$= -1,35.$

2 a) Caracteristica statică de transfer la circuitele integrate TTL.

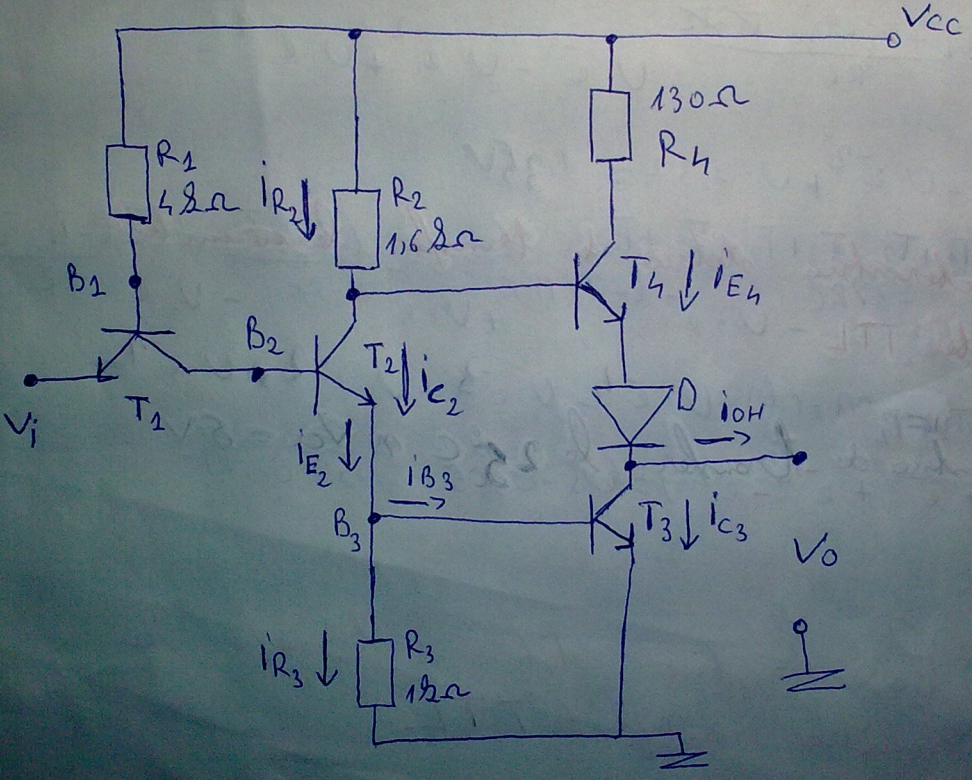


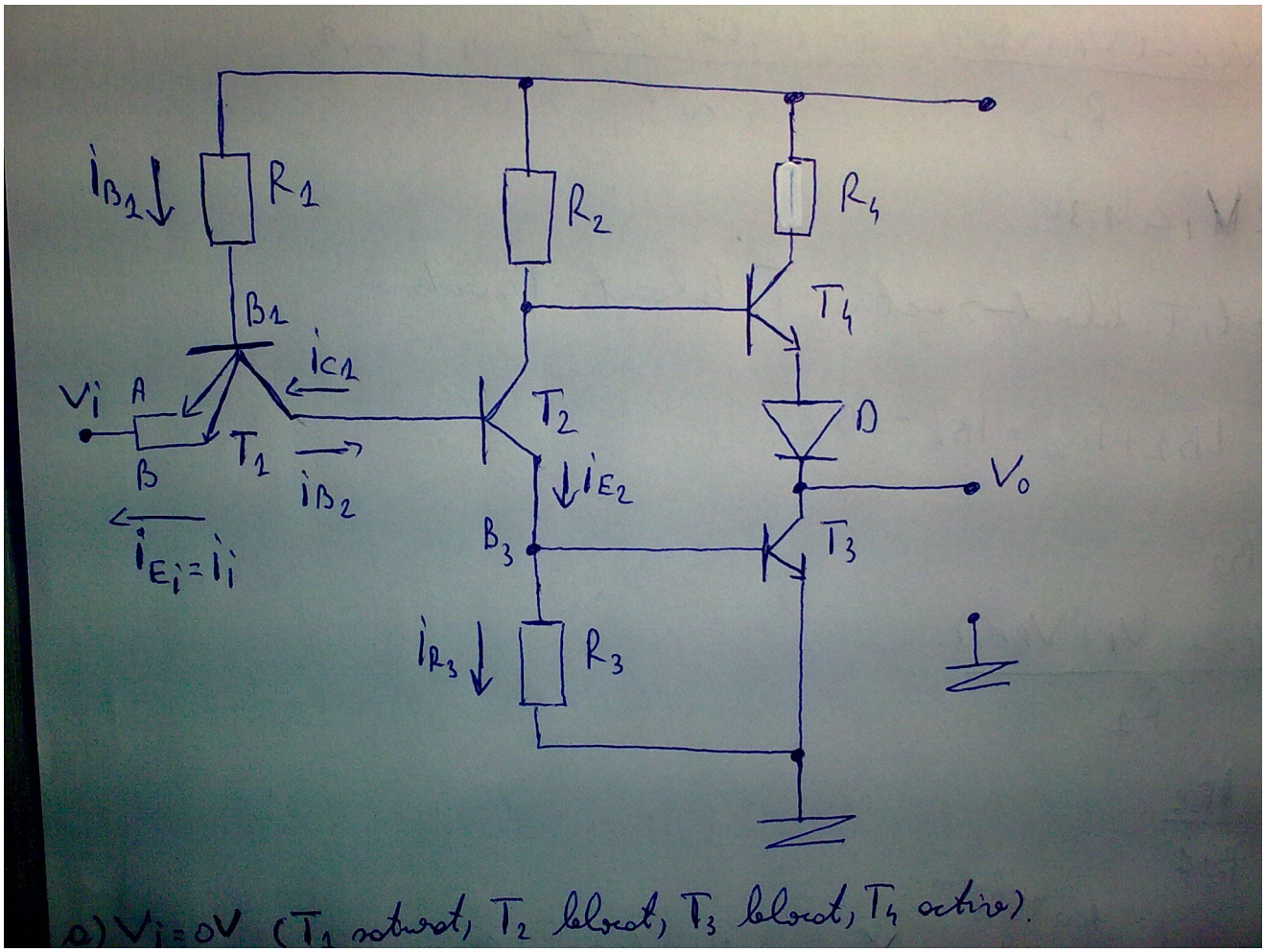
$V_o = f(V_i)$

interare

b) Definirea nivelelor logice de la intrare pe baza caracteristicii

c) Definirea nivelelor logice de la ieșire pe baza caracteristicii





a) $V_i = 0V$ (T_1 saturat, T_2 blocat, T_3 blocat, T_4 activ).

a) $V_i = 0V$ (T_1 saturat, T_2 blocat, T_3 blocat, T_4 activ).

$$i_i = i_{E_1} = i_{B_1} + i_{C_1}$$

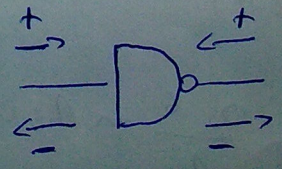
$$i_{B_1} = \frac{V_{cc} - V_{B_1}}{R_1} = \frac{V_{cc} - (V_i + V_{BE_1})}{R_1}$$

(V_{B_1})

$$i_{C_1} = -i_{B_2} = -i_0 \text{ neglijom} \Rightarrow T_2 \text{ blocat.}$$

$$i_i = \frac{V_{cc} - (V_i + V_{BE_1})}{R_1} = \frac{5 - (0 + 0{,}75)}{4 \cdot 10^3} = \frac{4{,}25}{4 \cdot 10^3} = 1{,}06 \text{ mA.}$$

$$\beta \cdot i_{B_1} > i_{C_1} \Rightarrow T_1 \text{ saturat.}$$



$\beta+1$

$$I_{E_2} = I_{R_3} + I_{B_3} \overset{I_{B_3} \text{ neglijăm}}{\cong} I_{R_3} = \frac{V_{B_3}}{R_3} = \frac{V_i + V_{BE_1} - V_{BC_1} - V_{BE_2}}{R_3}$$

Pentru $V_i = 0{,}3V$

$$I_i = \frac{V_{cc} - (V_i + V_{BE_1})}{R_1} = \frac{1}{\beta+1} \cdot \frac{V_i + V_{BE_1} - V_{BC_1} - V_{BE_2}}{R_3}$$

Pentru $V_i = 1{,}3V$

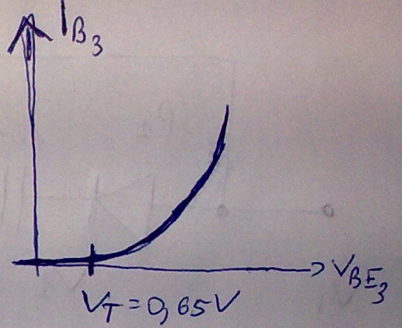
$\rightarrow T_2$ activ.

$$I_i = \frac{5 - (1{,}3 + 0{,}75)}{4 \cdot 10^3} - \frac{1}{20+1} \cdot \frac{1{,}3 + 0{,}75 - 0{,}75 - 0{,}7}{10^3} =$$

$$= \frac{2{,}95}{4}\,mA - \frac{1}{21} \cdot \frac{0{,}6}{1}\,mA = 0{,}74 - 0{,}03 = 0{,}71\,mA.$$

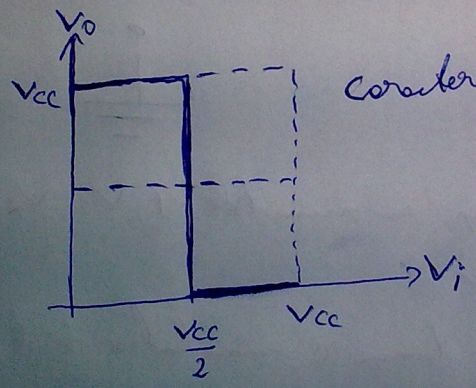
$i_{R_2} = i_{C_2} + i_{B_4}$; $i_{C_2} \approx i_{E_2} = i_{R_3} + i_{B_3}$

$i_{C_2} \sim i_{E_2}$



$V_{BEmax} = V_{BES} = 0,75V$

f) $V_i = 1,5V (2 \times 0,75)$



característica ideal.

g) $V_i = 2,25V$

$V_{B1} = V_i + \cancel{V_{BE_1}}^{=0}$

$V_{B1} = V_{BC_1} + V_{BE_2} + V_{BE_3} = 2,25V$

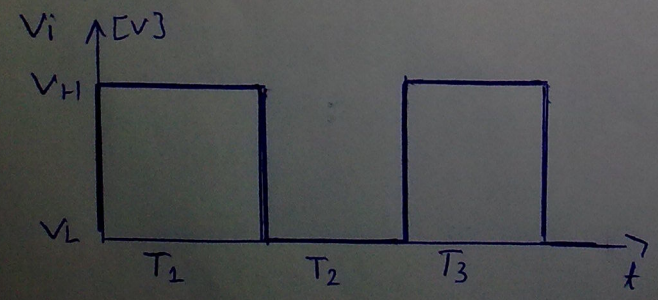
g) $V_i = 2,25V$

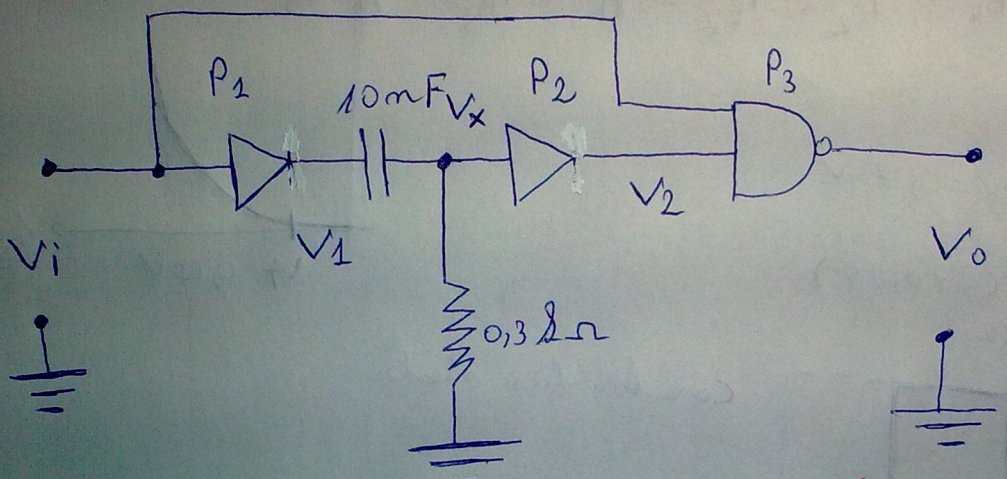
$V_{B1} = V_i + \cancel{V_{BE1}}^{=0}$

$V_{B1} = V_{BC1} + V_{BE2} + V_{BE3} = 2,25V$

T_{B2} - saturat, T_{B3} - saturat, T_{B4} - blocat, T_1 intră în regim invers (V_{BE1} - pol. invers, V_{BC1} - pol. direct).

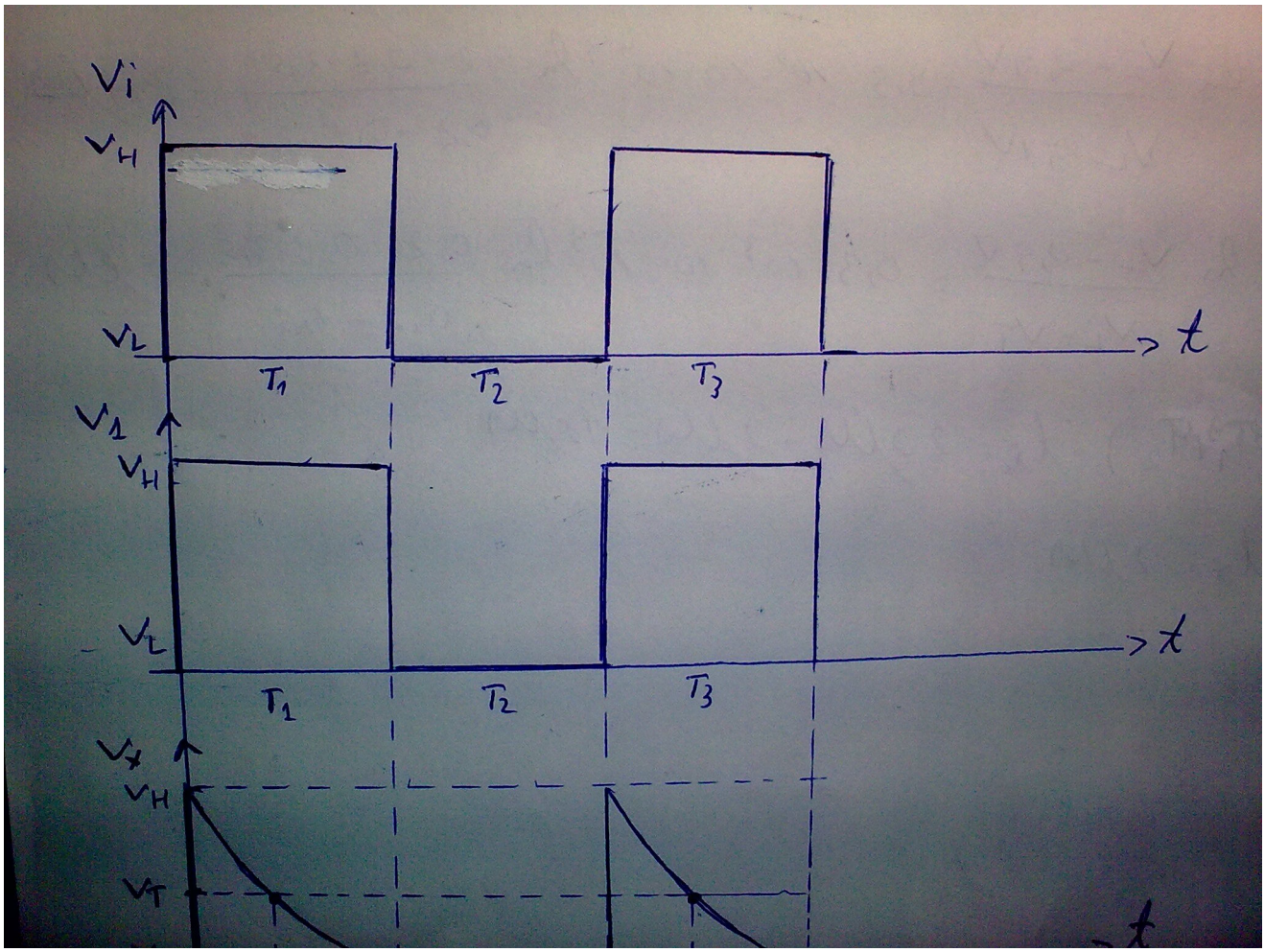
3. Se dă circuitul din figura de mai jos, la intrare căruia se aplică semnalul din figură, se cere:

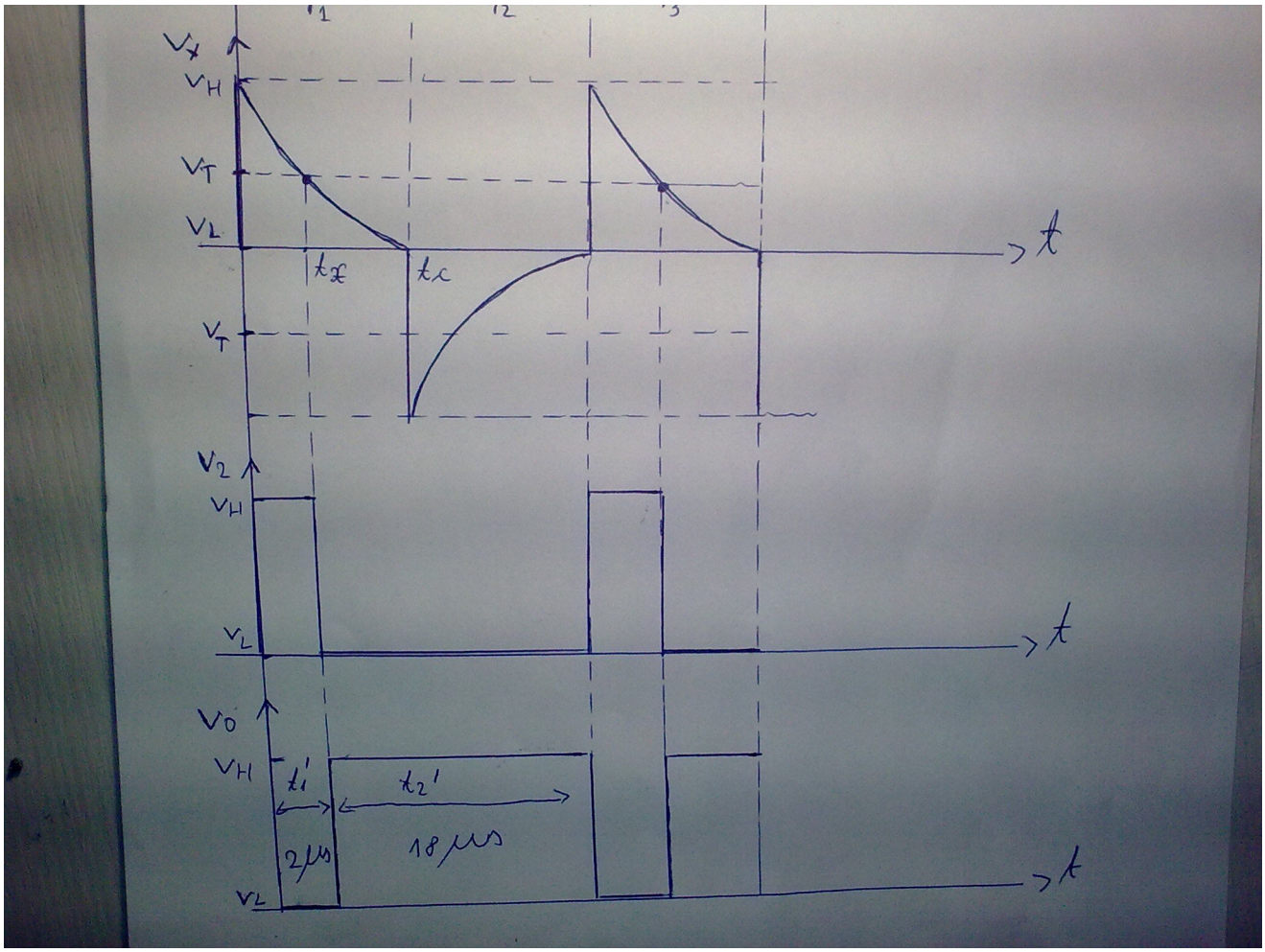




a) Ridicarea diagramelor de timp în punctele V_i, V_1, V_x, V_2 și V_o, unde $V_{H1} = 3,5\,V$ și $V_L = 0,2\,V$

b) Să se calculeze perioadele de timp a semnalului de la ieșire. Se vor neglija timpii de întârziere ai porților. Unde $T_1 = T_2 = T_3 = 10\,ns$


V_i
V_H
V_L
T_1
T_2
T_3
t
V_1
V_H
V_L
T_1
T_2
T_3
t
V_T
V_H
V_T
t


V_x
V_H
V_T
V_L
t
t_f
t_c
V_T
V_2
V_H
V_L
t
V_0
V_H
t_1'
t_2'
2 µs
18 µs
V_L
t

$$t_c = RC \ln \frac{V_L - 0{,}9V}{V_L - 0{,}1V} = 0{,}3 \cdot 10^3 \cdot 10 \cdot 10^{-9} \ln \frac{0{,}2 - 0{,}9 \cdot 3{,}5}{0{,}2 - 0{,}1 \cdot 3{,}5} = 8{,}9\,\mu s$$

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

$$t_2' = (T_1 + T_2) - t_x = 20\,\mu s - 2\,\mu s = 18\,\mu s$$

$$t_1' = t_x = 2\,\mu s.$$