ELECTRONICĂ DIGITALĂ

TEMĂ

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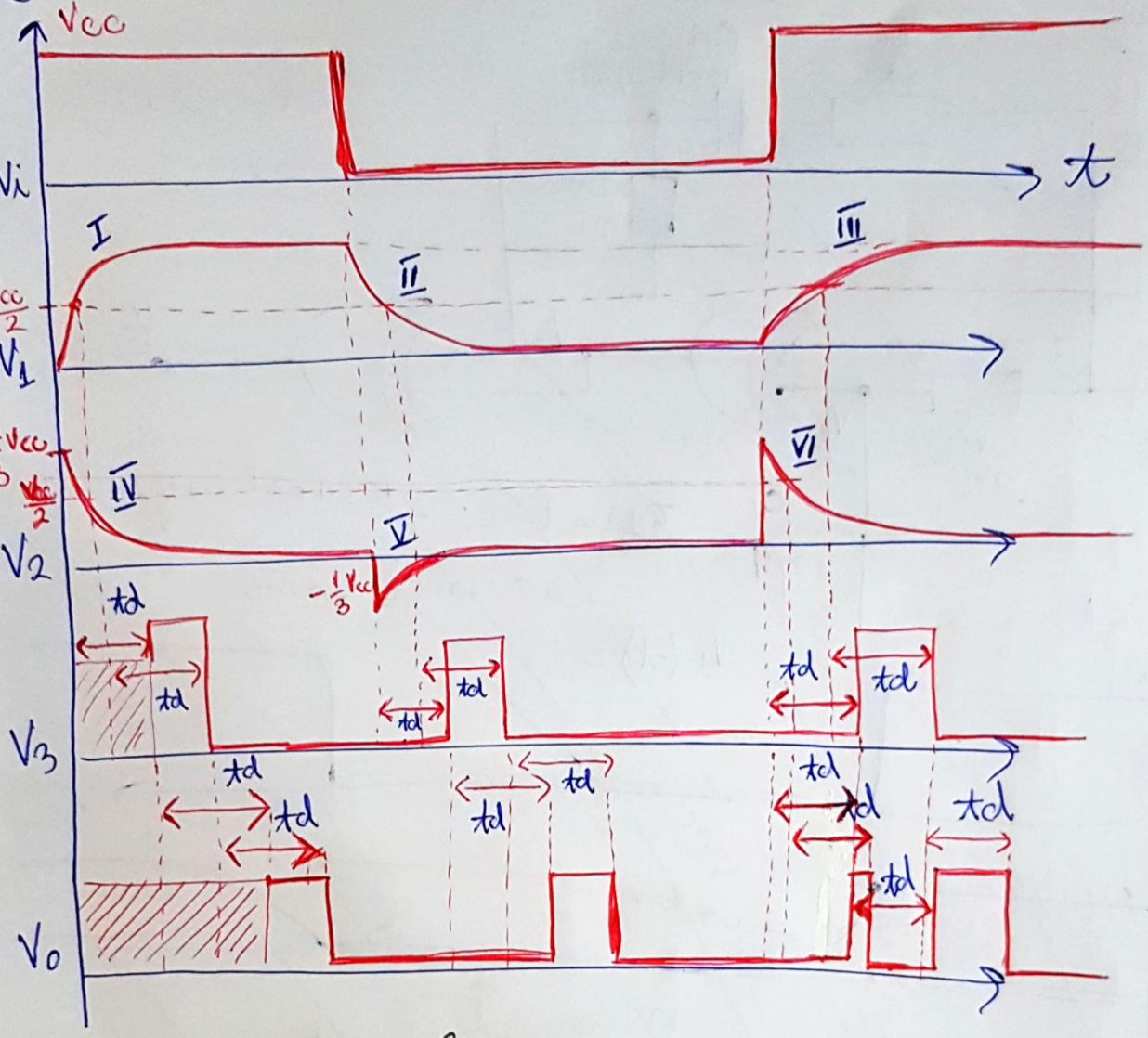
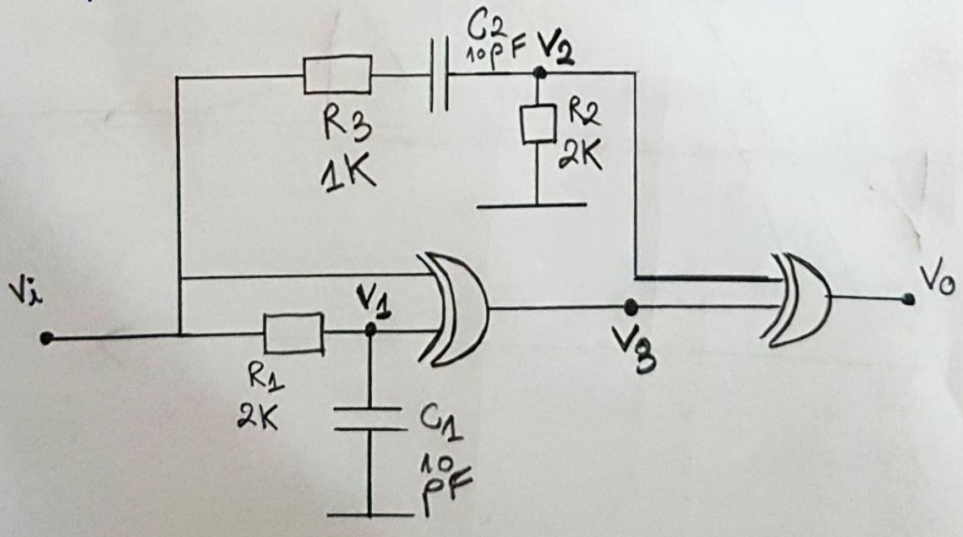
324CD

①


Vcc
Vi
t
I
II
III
Vcc/2
V1
2/3 Vcc
Vcc/2
IV
V
VI
V2
-1/3 Vcc
td
V3
Vo


C2
10PF
V2
R3
1K
R2
2K
Vi
V1
V3
Vo
R1
2K
C1
10
PF

Pentru V_1: $V_1(t) = V_1(0) \cdot e^{-\frac{t}{\tau_1}} + V_1(\infty) \cdot (1 - e^{-t/\tau_1})$

unde $\tau_1 = R_1 \cdot C_1 = 10pF \cdot 2K = 10 \cdot 10^{-12} \cdot 2 \cdot 10^3 =$

$= 20\ ms$ (const. de timp)

(I) $V_1(0) = 0V$; $V_1(\infty) = Vcc \Rightarrow$

$\Rightarrow V_1(t_1) = (1 - e^{-t_1/\tau_1}) \cdot Vcc = \frac{Vcc}{2} \Rightarrow$

$\Rightarrow \frac{1}{2} = e^{-t_1/\tau_1} \mid \ln \Rightarrow -\ln 2 = -t_1/\tau_1 \Rightarrow$

$\Rightarrow t_1 = \tau_1 \cdot \ln 2 \cong 14\ ms$ (timpul de crestere de la 0 la $Vcc/2$)

(II) $V_1(0) = Vcc$; $V_1(\infty) = 0 \Rightarrow$

$\Rightarrow V_1(t_2) = Vcc \cdot e^{-t_2/\tau_1} = Vcc/2 \Rightarrow$

$\Rightarrow e^{-t_2/\tau_1} = \frac{1}{2} \Rightarrow t_2 = \tau_1 \cdot \ln 2 \cong 14\ ms$ (timpul de descrestere de la Vcc la $Vcc/2$).

(III) $t_3 = t_1 = 14\ ms$ (Analog I)

Pentru V_2: $V_2(t) = V_2(0) \cdot e^{-t/\tau_2} + V_2(\infty) \cdot (1 - e^{-t/\tau_2})$

unde $\tau_2 = (R_3 + R_2) \cdot C_2 = 3K \cdot 10pF = 30\ ms$ (ct. de timp)

(IV) $V_2(0) = \frac{2}{3} Vcc$; $V_2(\infty) = 0V \Rightarrow$

$\Rightarrow V_2(t_4) = Vcc \cdot \frac{1}{2} = \frac{2}{3} Vcc \cdot e^{-t_4/\tau_2}$

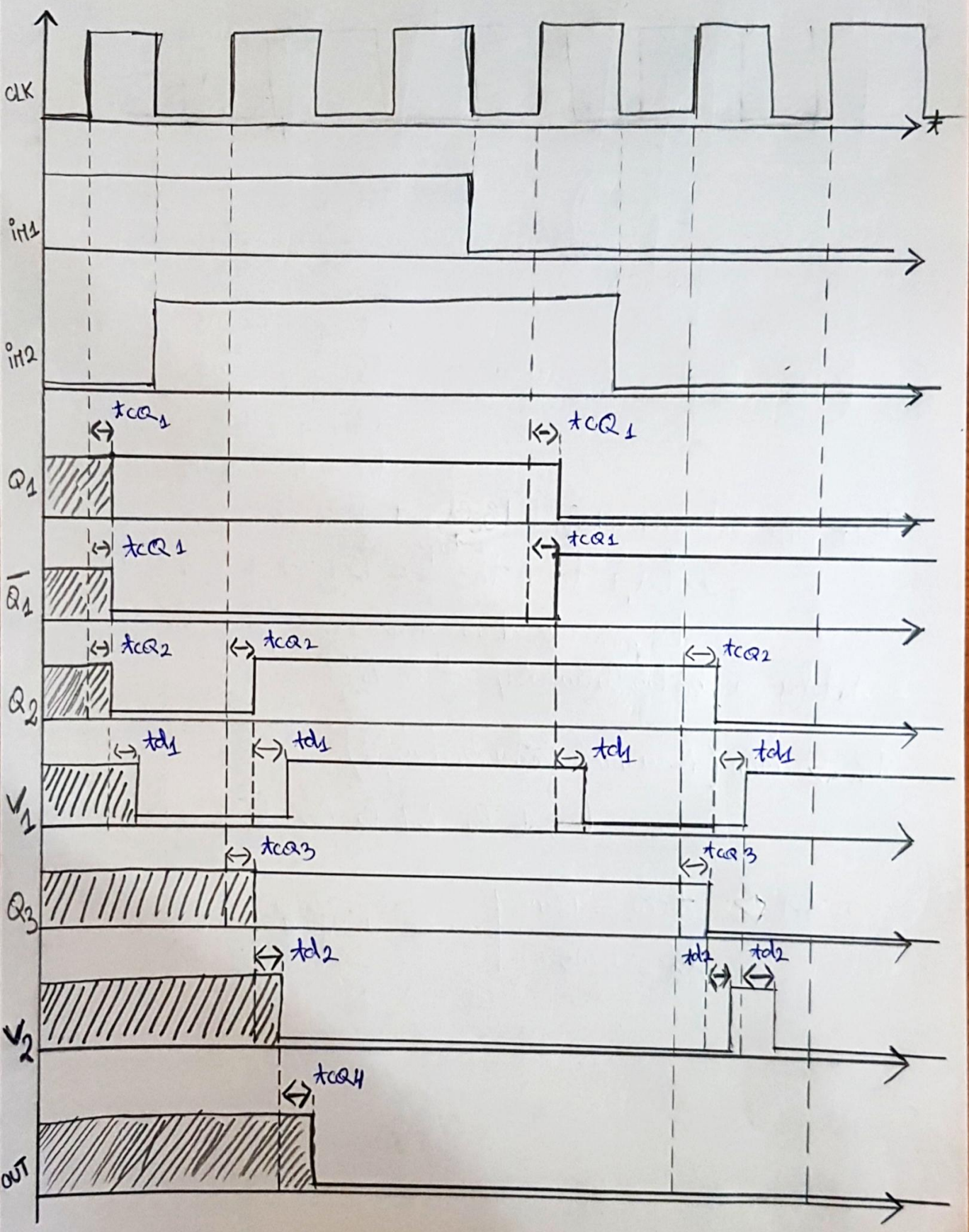
$\Rightarrow \frac{3}{4} = e^{-t_4/\tau_2} \mid \ln \Rightarrow \ln\left(\frac{3}{4}\right) = -t_4/\tau_2$

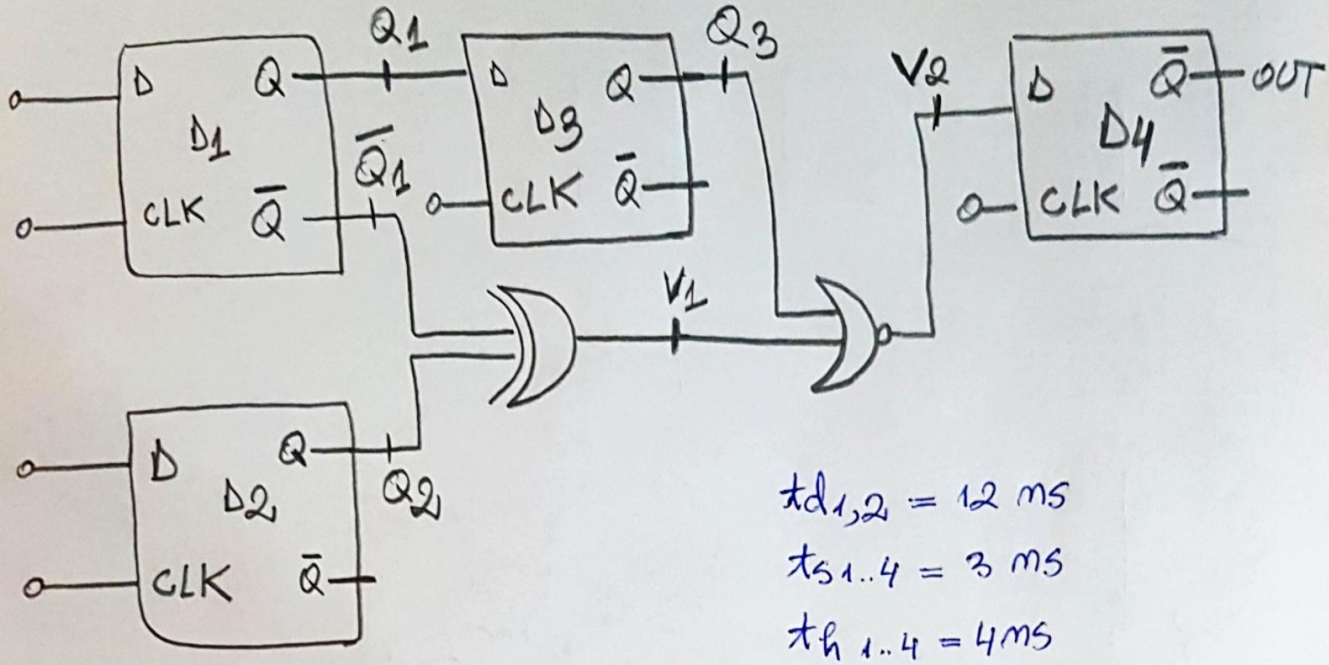
$t_4 \cong 0{,}287 \cdot 30 \cong 8{,}63$ ms (timpul de descreștere de la $\frac{2}{3}V_{CC}$ la $\frac{1}{2}V_{CC}$)

(V). timpul de aici nu merită calculat deoarece nu este relevant pentru ieșirea circuitului. (nu influențează cu nimic).

(VI). $t_6 = t_4 = 8{,}63$ ms (Analog IV)

(2)


CLK
i_{H1}
i_{H2}
t_{CQ1}
t_{CQ1}
Q_1
t_{CQ1}
t_{CQ1}
$\overline{Q_1}$
t_{CQ2}
t_{CQ2}
t_{CQ2}
Q_2
t_{d1}
t_{d1}
t_{d1}
t_{d1}
V_1
t_{CQ3}
t_{CQ3}
Q_3
t_{d2}
t_{d2}
t_{d2}
V_2
t_{CQ4}
OUT



$t_{d1,2} = 12\ ns$

$t_{s1..4} = 3\ ns$

$t_{h\,1..4} = 4\ ns$

$t_{CQ1..4} = 16\ ns$

$T_{CLK\ MIN} = \underbrace{T_{DRUM\ MAXIM}}_{\downarrow} + T_{setup} + T_{CQ} =$

$= \underbrace{2 \cdot t_d}_{\text{prin cele două porți logice până la intrarea datelor a bistabilului } D_4, \text{ de la } D_2} + t_s + t_{CQ} = 2 \cdot 12 + 3 + 16 = 43\ ns$

$t_h < \min(\underbrace{\Delta \text{ruiuri între bistabile}}_{\text{de la } D_1 \text{ la } D_3\ (Q_1 \rightarrow D_3)})$

$\Rightarrow t_h < \begin{matrix} t_{CQ} = 16\ ns \\ t_h = 4\ ns \end{matrix} \Rightarrow$ se verifică