LAB SĂPTĂMÂNA 2 - CD

CIRCUITE LINIARE - RC trece-jos

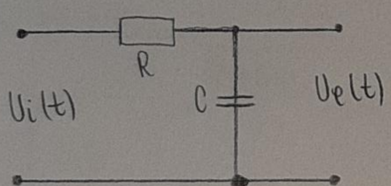
1. SCOPUL LUCRĂRII

Scopul lucrării este de a studia experimental trecerea semnalelor de diferite forme prin circuitele RC-trece jos.

2. CONSIDERAȚII TEORETICE

Circuitele de tip RC, LC și RLC sunt circuite liniare. De asemenea, transformatoarele de impulsuri, liniile de întârzieri și amplificatoarele de impulsuri. În cadrul circuitelor liniare semnalele nesinusoidale suferă distorsiuni, pe când cele sinusoidale au, la ieșire, tot o formă sinusoidală.

2.1 CIRCUITE RC-TRECE JOS



Circuitul RC-trece jos are proprietatea că are atenuarea în funcție de frecvența semnalului de intrare. Dacă semnalul aplicat la intrare este nesinusoidal, componentele sale de frecvență joasă apar la ieșire cu o atenuare mai mică decât cele de frecvență înaltă.

a) Avem semnalul de intrare sinusoidal de frecvență f

- ~~at~~ atenuarea:

$$A = \frac{1}{\sqrt{1+(\omega RC)^2}}$$

$$A = \frac{U_e}{U_i}$$

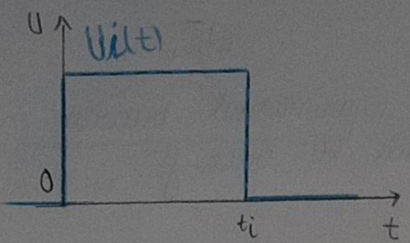
- defazajul:

$$\varphi = -\operatorname{arctg}(\omega RC)$$

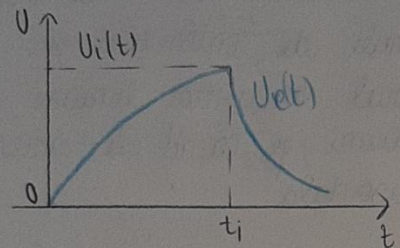
$$\varphi = \frac{t \cdot 360^\circ}{T}$$

b) Semnalul de intrare impuls (T - perioada, ti - durata)

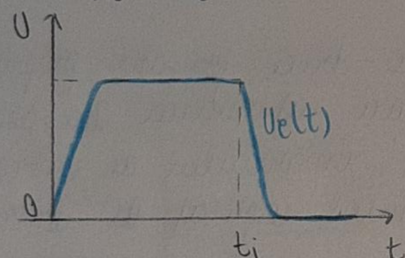
~~o RC = ti~~



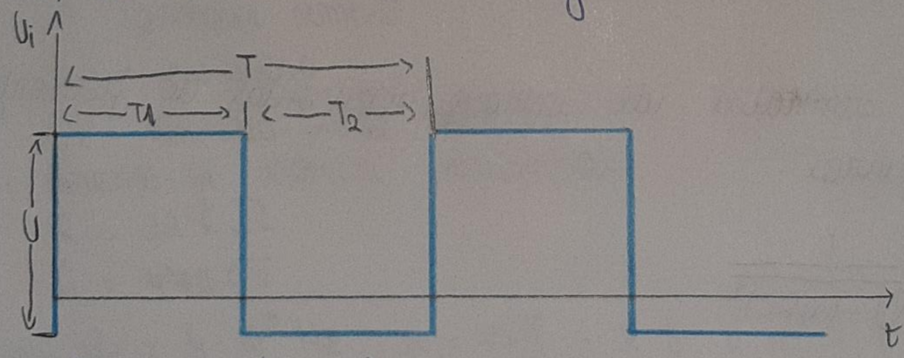
o RC < ti



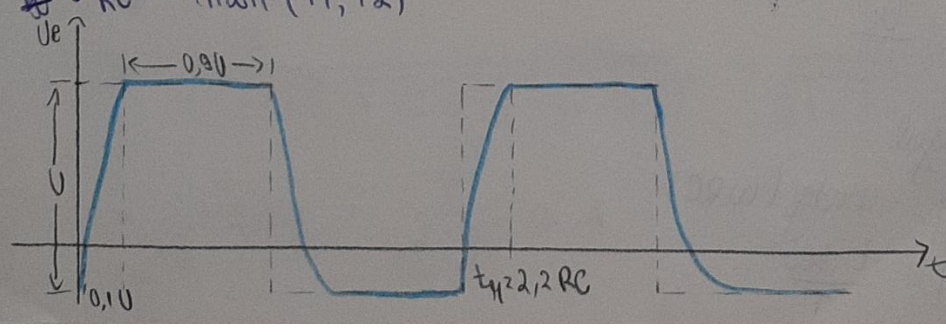
o RC << ti



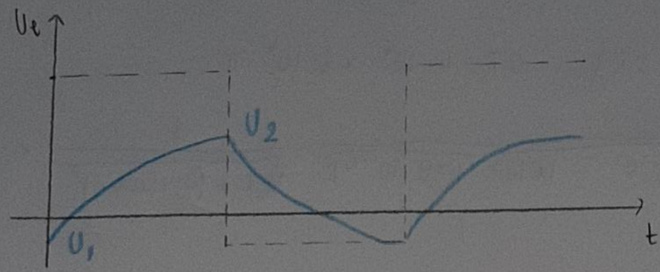
c) Semnal de intrare rectangular



• RC << min (T_1, T_2)



• $RC \ll \max(T_1, T_2)$



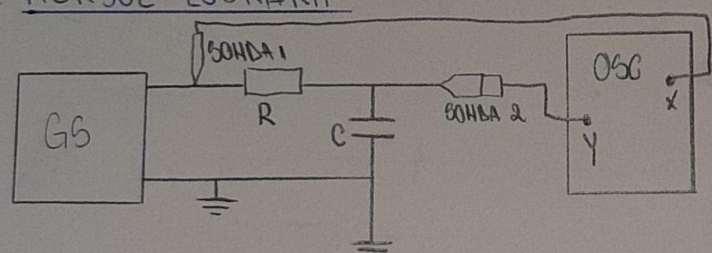
Pentru $T_1 = T_2 = \frac{1}{2}T$

$$U_1 = -\frac{U}{2} * \frac{1-e^{-x}}{1+e^{-x}}$$

$$U_2 = \frac{U}{2} \cdot \frac{1-e^{-x}}{1+e^{-x}}$$

$$x = \frac{T}{2RC}$$

3. MERSUL LUCRĂRII



GS - generator semnal
OSC - osciloscop
X, Y - intrări sonde osciloscop

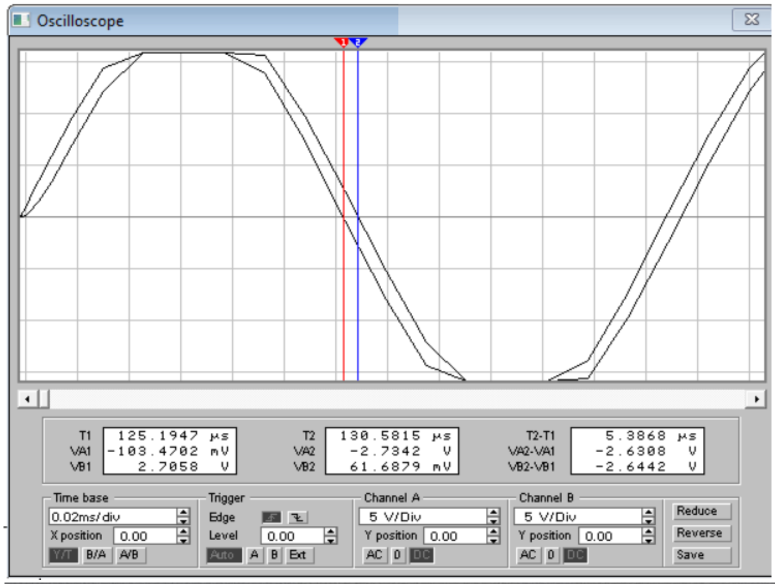
3.1.1 Semnal de intrare sinusoidal
$R = 12\,k\Omega$
$C = 470\,pF$

A. a) $f_1 = 4 \cdot 10^3\,Hz$, $\omega_1 = 2\pi f_1 = 2 \cdot \pi \cdot 4 \cdot 10^3 = 8 \cdot 10^3 \pi$

$$A_1 = \frac{1}{\sqrt{1+(8 \cdot 10^3 \pi \cdot 12 \cdot 10^3 \cdot 470 \cdot 10^{-12})^2}} = \frac{1}{\sqrt{1+(4{,}512 \cdot 10^{-2} \cdot \pi)^2}} =$$

$$= \frac{1}{\sqrt{1+0{,}02}} = \frac{1}{\sqrt{1{,}02}} \simeq 1$$

$$\varphi_1 = \frac{\Delta t_1 \cdot 360^\circ}{T_1} = \frac{65\,\mu s \cdot 360^\circ}{250\,\mu s} \approx \cancel{90^\circ}\ 93,6^\circ$$

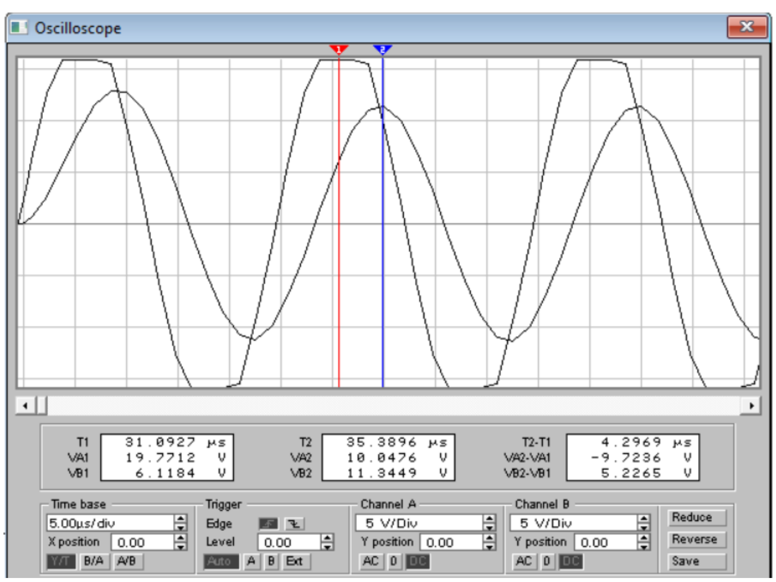


b) $f_2 = 4 \cdot 10^4\ Hz = 40\ kHz$

$\omega_2 = 8 \cdot 10^4 \pi$

$$A_2 = \frac{1}{\sqrt{1+(\omega_2 RC)^2}} = \frac{1}{\sqrt{1+(0,4512\pi)^2}} = \frac{1}{\sqrt{3}} \approx 0,58$$

$$\cancel{\measuredangle}\ \varphi_2 = \frac{\Delta t_2 \cdot 360^\circ}{T_2} = \frac{6\,\mu s \cdot 360^\circ}{25\,\mu s} \approx 86,4^\circ$$

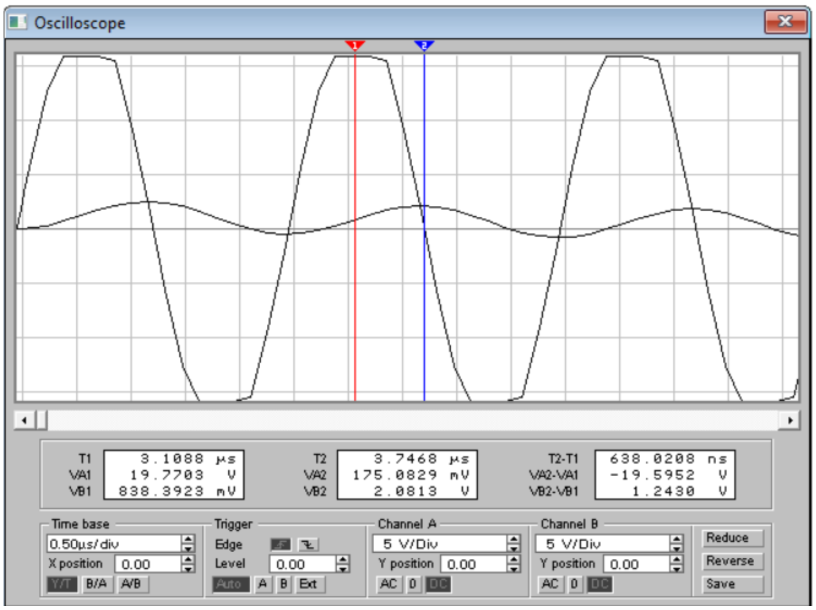


c) $f_3 = 4 \cdot 10^5 \, Hz = 400 \, kHz$

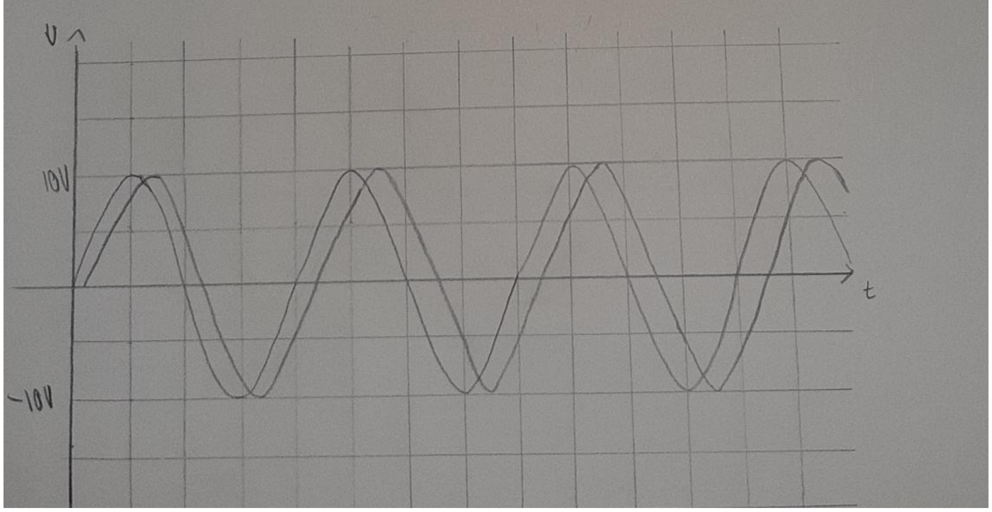
$\omega_3 = 8 \cdot 10^5 \pi$

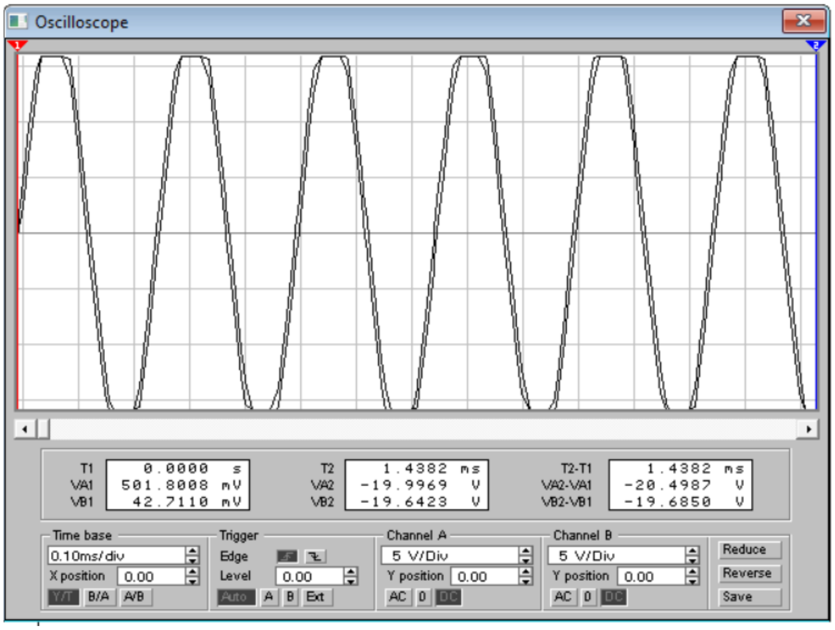
$$A_3 = \frac{1}{\sqrt{1+(\omega_3 RC)^2}} \simeq \frac{1}{\sqrt{1+200}} = \frac{1}{14,18} \simeq 0,07$$

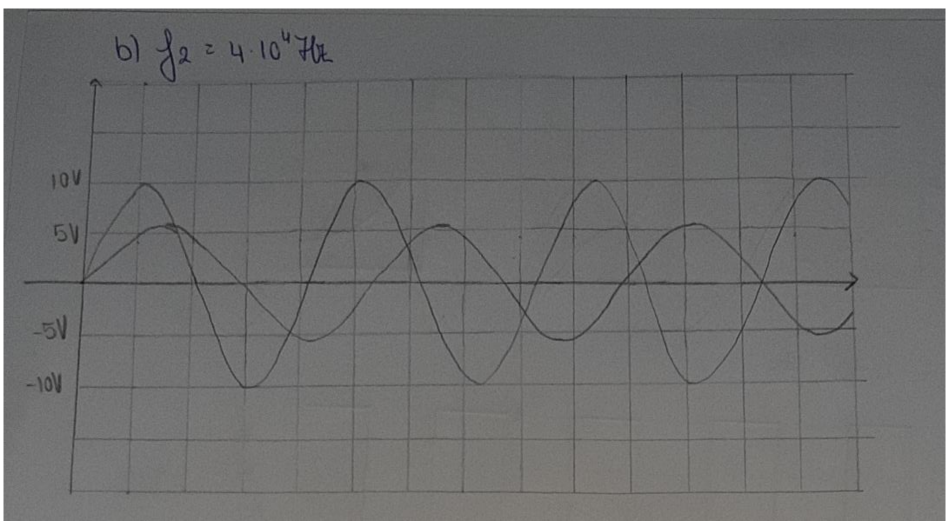
$$\varphi_3 = \frac{t_3 \cdot 360^\circ}{T_3} = \frac{650 \, ns \cdot 360^\circ}{2,5 \, \mu s} \simeq 93,6^\circ$$

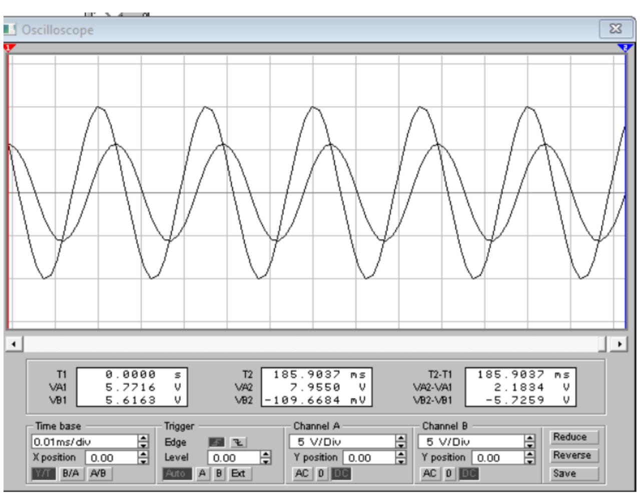


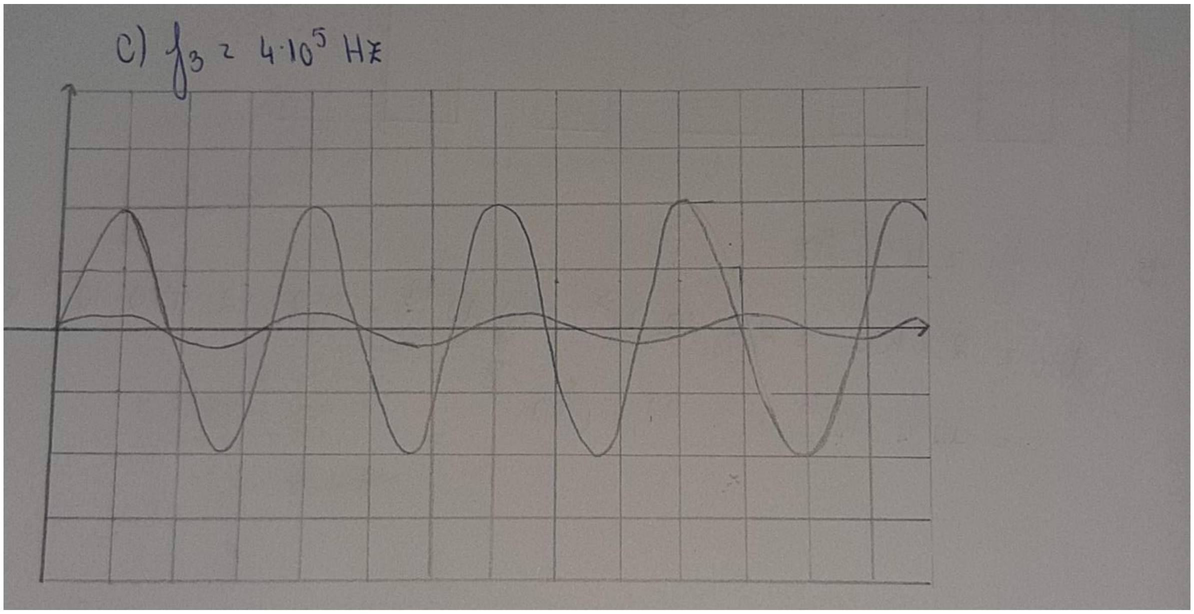
B. a) $f_1 = 4 \cdot 10^3 \, Hz$

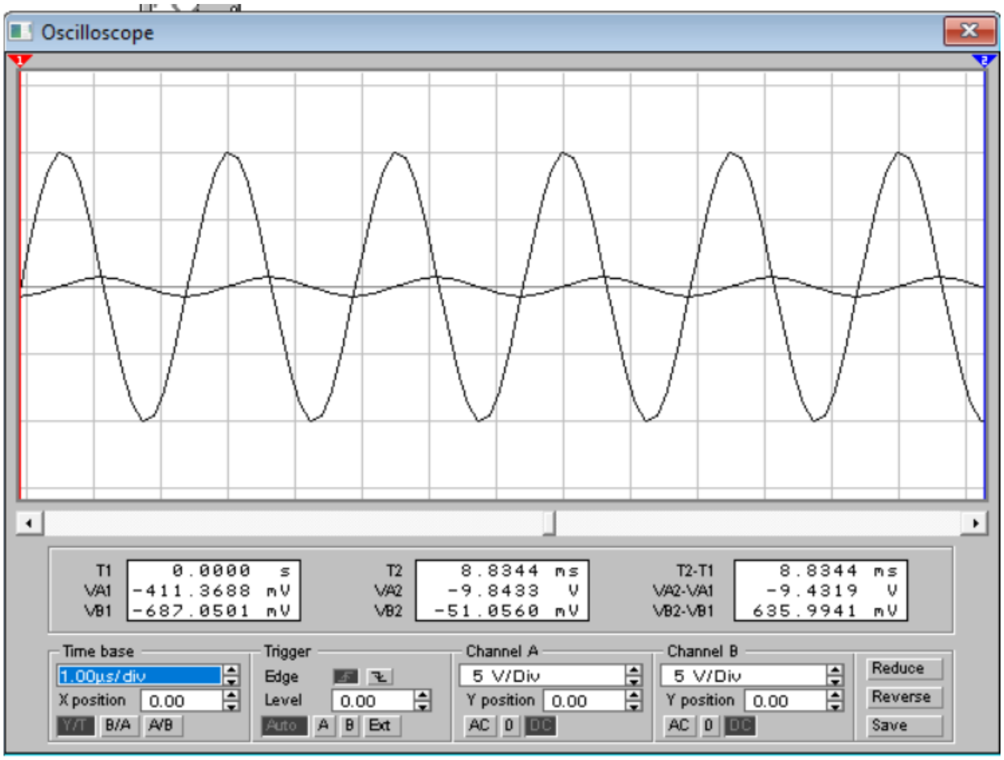


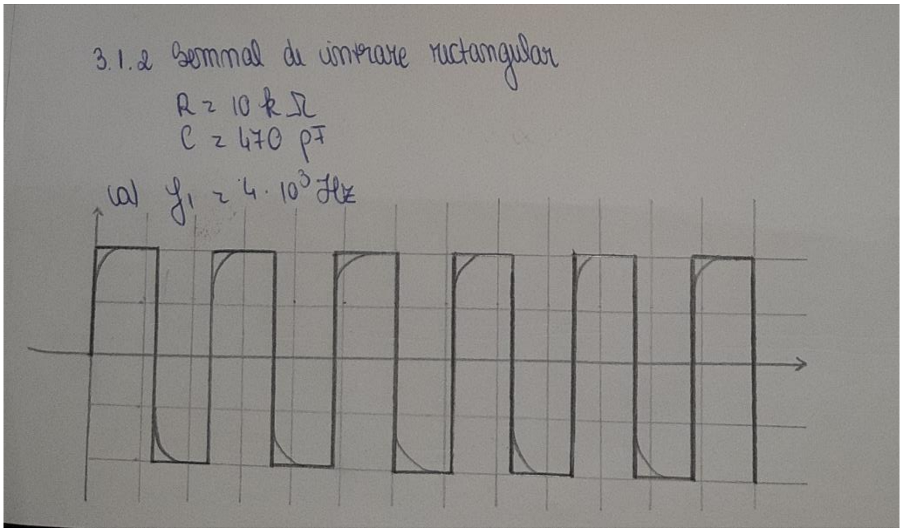

Oscilloscope
T1 0.0000 s
VA1 501.8008 mV
VB1 42.7110 mV
T2 1.4382 ms
VA2 -19.9969 V
VB2 -19.6423 V
T2-T1 1.4382 ms
VA2-VA1 -20.4987 V
VB2-VB1 -19.6850 V
Time base 0.10ms/div
X position 0.00
Y/T B/A A/B
Trigger Edge Level 0.00
Auto A B Ext
Channel A 5 V/Div
Y position 0.00
AC 0 DC
Channel B 5 V/Div
Y position 0.00
AC 0 DC
Reduce
Reverse
Save

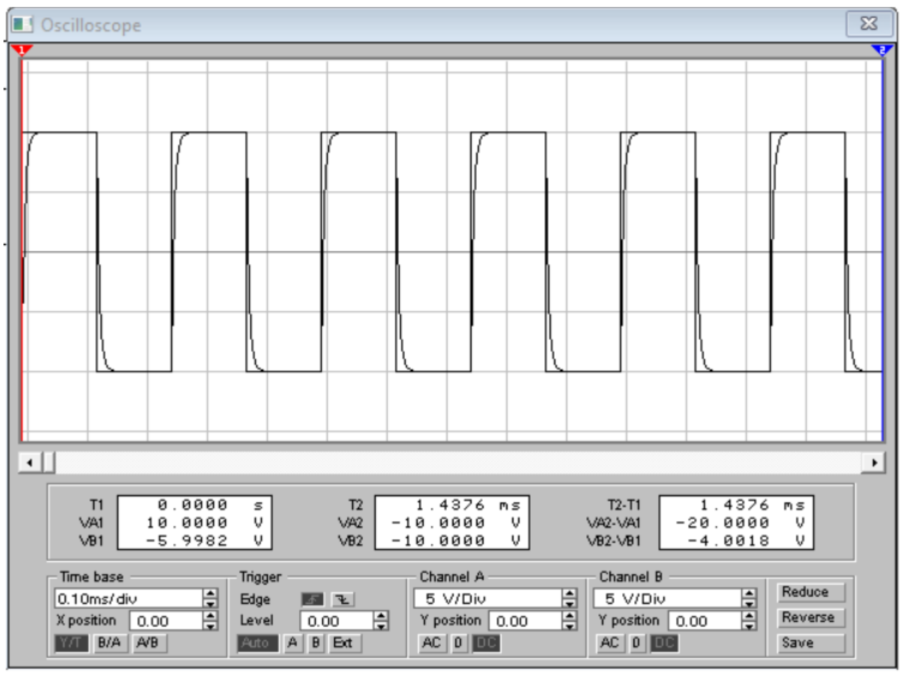

b) $f_2 = 4 \cdot 10^4$ Hz
10V
5V
-5V
-10V

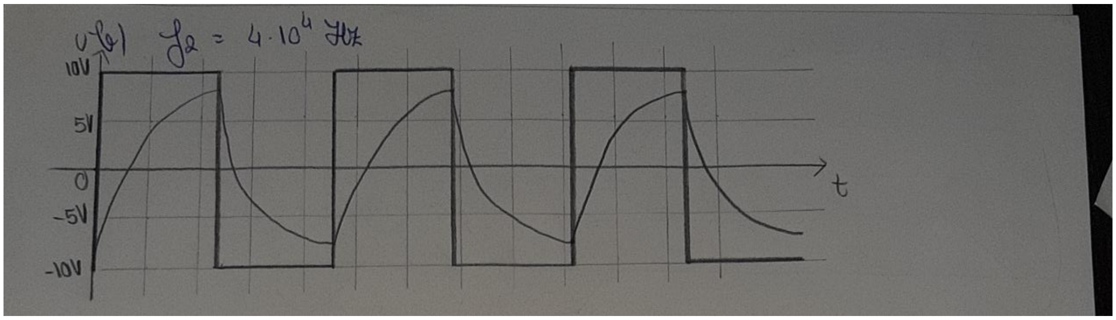

Oscilloscope
T1 0.0000 s
VA1 5.7716 V
VB1 5.6163 V
T2 185.9037 ms
VA2 7.9550 V
VB2 -109.6684 mV
T2-T1 185.9037 ms
VA2-VA1 2.1834 V
VB2-VB1 -5.7259 V
Time base 0.01ms/div
X position 0.00
Y/T B/A A/B
Trigger Edge Level 0.00
Auto A B Ext
Channel A 5 V/Div
Y position 0.00
AC 0 DC
Channel B 5 V/Div
Y position 0.00
AC 0 DC
Reduce
Reverse
Save

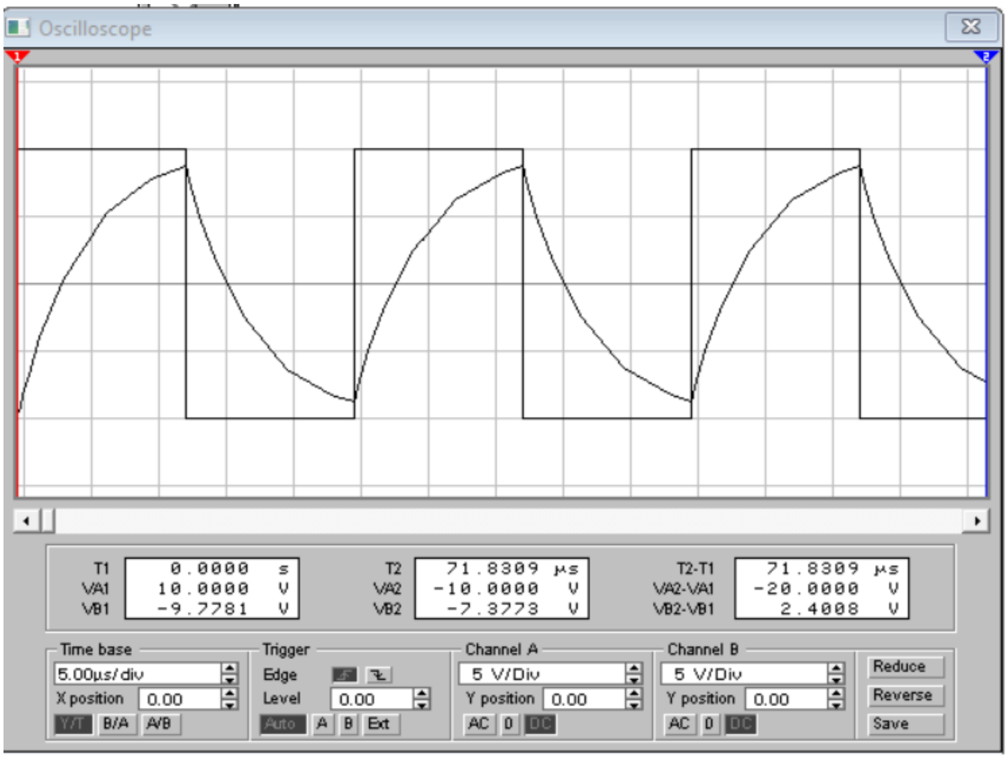

c) $f_3 = 4 \cdot 10^5$ Hz

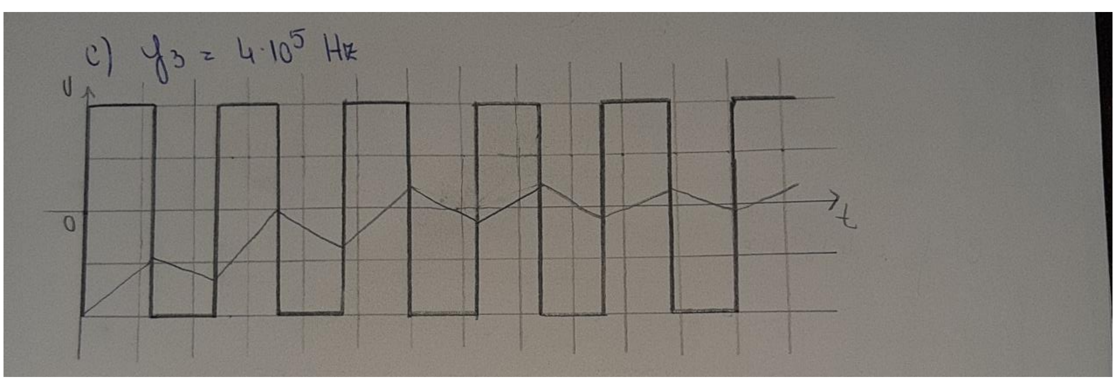

Oscilloscope
T1 0.0000 s
VA1 -411.3688 mV
VB1 -687.0501 mV
T2 8.8344 ms
VA2 -9.8433 V
VB2 -51.0560 mV
T2-T1 8.8344 ms
VA2-VA1 -9.4319 V
VB2-VB1 635.9941 mV
Time base
1.00µs/div
X position 0.00
Y/T B/A A/B
Trigger
Edge
Level 0.00
Auto A B Ext
Channel A
5 V/Div
Y position 0.00
AC 0 DC
Channel B
5 V/Div
Y position 0.00
AC 0 DC
Reduce
Reverse
Save

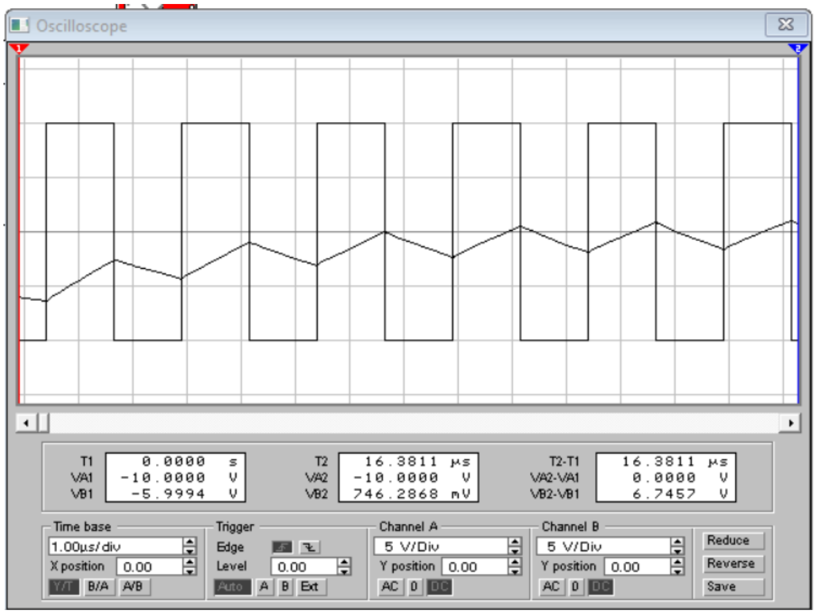

3.1.2 Semnal de intrare rectangular
R = 10 kΩ
C = 470 pF
(a) f1 = 4 · 10^3 Hz


Oscilloscope
T1 0.0000 s
VA1 10.0000 V
VB1 -5.9982 V
T2 1.4376 ms
VA2 -10.0000 V
VB2 -10.0000 V
T2-T1 1.4376 ms
VA2-VA1 -20.0000 V
VB2-VB1 -4.0018 V
Time base
0.10ms/div
X position 0.00
Y/T B/A A/B
Trigger
Edge
Level 0.00
Auto A B Ext
Channel A
5 V/Div
Y position 0.00
AC 0 DC
Channel B
5 V/Div
Y position 0.00
AC 0 DC
Reduce
Reverse
Save


u(t)
b) f2 = 4·10^4 Hz
10V
5V
0
-5V
-10V
t


Oscilloscope
T1 0.0000 s
VA1 10.0000 V
VB1 -9.7781 V
T2 71.8309 µs
VA2 -10.0000 V
VB2 -7.3773 V
T2-T1 71.8309 µs
VA2-VA1 -20.0000 V
VB2-VB1 2.4008 V
Time base
5.00µs/div
X position 0.00
Y/T B/A A/B
Trigger
Edge
Level 0.00
Auto A B Ext
Channel A
5 V/Div
Y position 0.00
AC 0 DC
Channel B
5 V/Div
Y position 0.00
AC 0 DC
Reduce
Reverse
Save


c) f3 = 4·10^5 Hz
U
0
t



$$3.\quad f = f_1 = 4 \cdot 10^3\ \text{Hz}$$

$$t_H = 2{,}2RC = 2{,}2 \cdot 10 \cdot 10^3 \cdot 470 \cdot 10^{-12} = 2{,}2 \cdot 10 \cdot 470 \cdot 10^{-3} \cdot 10^{-6} =$$

$$= 10{,}34 \cdot 10^{-6}\ s = 10{,}34\ \mu s$$