ALEXIA - SÂNZIANA
BALAMOTI
1.1.

Lucrarea 1

Circuite liniare RC trece-jos

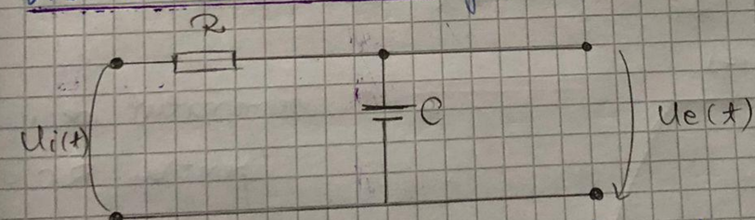
1. Scopul lucrării

- se va studia trecerea diverselor semnale prin circuite de tipul RC trece-jos

2. Considerații teoretice

- la trecerea unui semnal nesinusoidal printr-un circuit liniar apare fenomenul de „transformare liniară" a semnalului, acesta suferind distorsiuni
- exemple de circuite liniare:
  * circuite cu el. pasive: RC, RL, RLC
  * transformatoarele de impulsuri
  * linii de întârzieri
  * amplificatoare de impulsuri

2.1. Circuite RC trece-jos



- atenuarea (A) depinde de frecvența semnalului de intrare
- pentru un semnal nesinusoidal, componentele de frecvență joasă, apar cu o atenuare mai mică la ieșire decât componentele cu frecvență mai mare

ALEXIA - SÂNZIANA BALAMOTI
1.1.

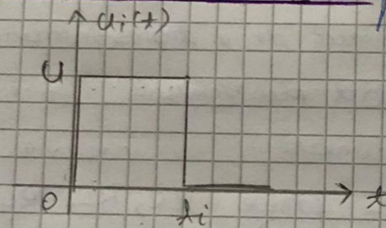
2.1.1. semnalul sinusoidal

f = frecvența semnalului ; $\omega = 2\pi f$ (pulsația semnalului)

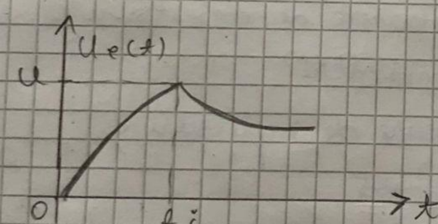
$$A(\omega) = \frac{1}{\sqrt{1+(\omega RC)^2}} \quad ; \quad \varphi(\omega) = -\operatorname{arctg}(\omega RC)$$

$$\underbrace{A = \frac{U_e}{U_i}}_{\text{atenuarea}} \quad ; \quad \underbrace{\varphi = \frac{t \cdot 360^\circ}{T}}_{\text{defazajul}}$$

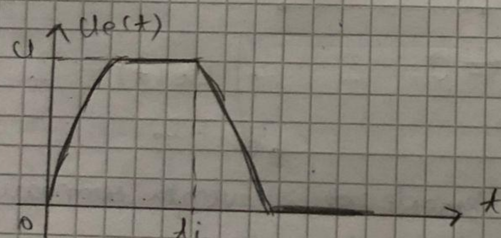
2.1.2. semnalul impuls



semnalul de intrare

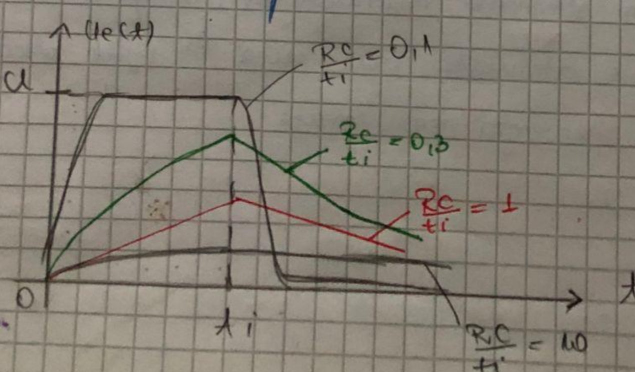


semnalul de ieșire pentru $RC > t_i$



semnalul de ieșire pentru $RC \ll t_i$

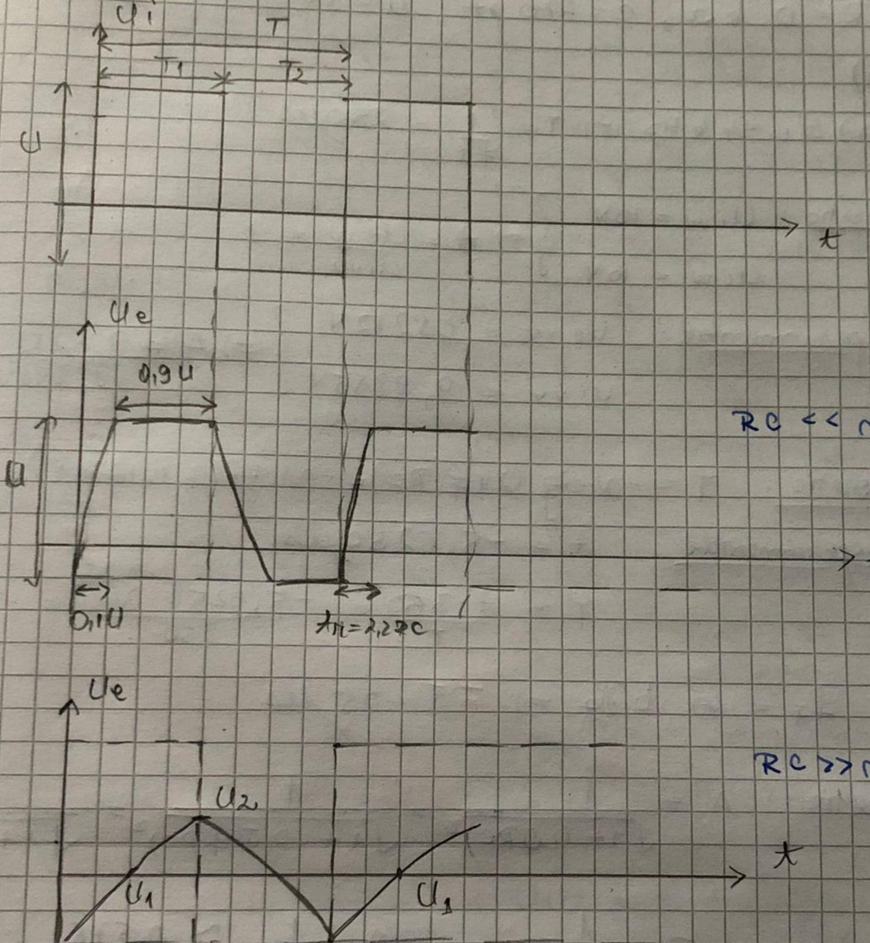
- variația răspunsurilor la diferite RC:



2.1.3. semnalul rectangular

ALEXIA-SÂNZIANA BALAMOTI
1.1.

- diagrame pt. valori foarte mici, respectiv valori foarte mari ale RC:



$RC << \min(T_1, T_2)$

$RC >> \max(T_1, T_2)$

- dacă timpul de ridicare t_r este mic în comparație cu T_1, T_2 semnalul de ieșire va fi aproximativ asemănător cu cel de intrare

- pentru $T_1 = T_2 = \frac{T}{2}$:

$U_1 = -\frac{U}{2} \cdot \frac{1-e^{-x}}{1+e^{-x}}$; $U_2 = \frac{U}{2} \cdot \frac{1-e^{-x}}{1+e^{-x}}$; $x = \frac{T}{2RC}$

ALEXIA - SÂNZIANA BALAMOTI
1.1.

3. Mersul lucrării

3.1.1. semnalul de intrare sinusoidal

$R = 12\ k\Omega,\ C = 470\ pF;\ U = 5V$

a)

a) $f_1 = 4\ kHz \Rightarrow T = \frac{1}{f_1} = 250\ \mu s$

A: teoretic: $U_{ivv} = 10V$, $U_{iw} = 10V$ $\Rightarrow A = \frac{U_{ew}}{U_{ivv}} = 1$

experimental: $U_{evv} = 9{,}8212V$, $U_{ivv} = 9{,}9985V$ $\Rightarrow A = \frac{9{,}8212}{9{,}9985} = 0{,}9822 \simeq 1$

φ: teoretic: $\varphi = -arctg(2\pi f RC) = -arctg(0{,}1416768) = -8{,}064^\circ$

experimental: $t = -5{,}6250\ \mu s$

$\varphi = \frac{t \cdot 360^\circ}{T} = \frac{-5{,}6250 \cdot 360^\circ}{250} = -8{,}1^\circ$

b) $f_2 = 40\ kHz \Rightarrow T = 25\ \mu s$

A: teoretic: $A = \frac{1}{\sqrt{1+(\omega RC)^2}} = \frac{1}{\sqrt{1+(2\pi f RC)^2}} = \frac{1}{\sqrt{1+1{,}416768^2}}$

$= \frac{1}{\sqrt{3{,}007231567 8}} \simeq \frac{1}{1{,}73} \simeq 0{,}578$

experimental: $U_{ew} = 5{,}6525V$, $U_{iw} = 9{,}9449V$ $\Rightarrow A = \frac{5{,}6525}{9{,}9449} = 0{,}5683$

φ: teoretic: $\varphi = -arctg(\omega RC) = -arctg(1{,}416768) = -54{,}78^\circ$

experimental: $t = -3{,}94\ \mu s$

$\varphi = \frac{t \cdot 360^\circ}{T} = \frac{-3{,}94 \cdot 360}{25} = -56{,}736^\circ$

c) $f_3 = 400\ kHz \Rightarrow T = 2{,}5\ \mu s$

ALEXIA-SANZIANA BALAMOTI 1.1.

A: teoretic: $A = \frac{1}{\sqrt{1+(\omega RC)^2}} = \frac{1}{\sqrt{1+(14{,}16768)^2}} \simeq$

$\simeq \frac{1}{\sqrt{1+200{,}72615}} \simeq \frac{1}{14{,}202927} \simeq 0{,}07$

experimentale: $U_{e\,vv} = 689{,}6246\ mV$, $U_{i\,vv} = 9{,}9686\ V$ $\Rightarrow A = \frac{0{,}6896246}{9{,}9686} = 0{,}0691$.

teoretic: $\varphi = -\mathrm{arctg}(\omega RC) = -\mathrm{arctg}(14{,}16768) = -85{,}96°$

experimentale: $t = -594{,}7581\ ns$

$\varphi = \frac{t \cdot 360°}{T} = \frac{-0{,}5947581 \cdot 360°}{2{,}5} = -85{,}64°$

b) osciloagramele $U_e - U_i$ sunt inserate mai jos pt. fiecare dintre cele 3 cazuri

c) • $f = 40\ kHz \Rightarrow$ experimentale: $\begin{cases} U_1 = -2{,}7618 \\ U_2 = 2{,}7618 \end{cases}$

teoretic: $\begin{cases} x = \frac{T}{2RC} = \frac{25 \cdot 10^{-6}}{2 \cdot 12 \cdot 10^3 \cdot 470 \cdot 10^{-12}} = \\ = \frac{2500}{24 \cdot 47} \simeq 2{,}21 \\ U_{1/2} = \mp 2{,}5 \cdot \frac{1-e^{-2{,}21}}{1+e^{-2{,}21}} \simeq \mp 2{,}005\ V \end{cases}$

• $f = 400\ kHz \Rightarrow$ experimentale: $\begin{cases} U_1 = -343{,}11\ mV \\ U_2 = 343{,}11\ mV \end{cases}$

teoretic: $\begin{cases} x = 0{,}22 \\ U_{1/2} = \mp 2{,}5 \cdot \frac{1-e^{-0{,}22}}{1+e^{-0{,}22}} \simeq 273\ mV \end{cases}$

ALEXIA - SÂNZIANA BALAMOTI 1.1.

3.1.2. Semnal de intrare rectangular

$R = 10K\Omega$; $C = 470pF$; $U = 5V$

a) Semnalele sunt prezentate mai jos

b) $f = 4kHz \Rightarrow t_r \simeq 11,41s$ (experimental)

$t_r = 2,2RC = 2,2 \cdot 10^4 \cdot 47 \cdot 10^{-11} = 103,4 \cdot 10^{-7} = 10,34\,\mu s$

c) • $f = 40kHz \Rightarrow$ experimental: $\begin{cases} U_1 = 484,5\,mV \\ U_2 = 4,5155\,V \end{cases}$

teoretic: $x = \frac{T}{2RC} = \frac{2,5 \cdot 10^{-6}}{2 \cdot 10^4 \cdot 47 \cdot 10^{-11}} = 2,6$

$U_{1,2} = \mp 2,5 \cdot \frac{1-e^{-2,6}}{1+e^{-2,6}} \simeq \mp 2,15V$

cum pe simulare offset $= 2,5 \Rightarrow$

$\Rightarrow U_{1,2} = 2,5 \mp 2,15V \Rightarrow$

$\Rightarrow \begin{cases} U_1 = 340\,mV \\ U_2 = 4,65V \end{cases}$

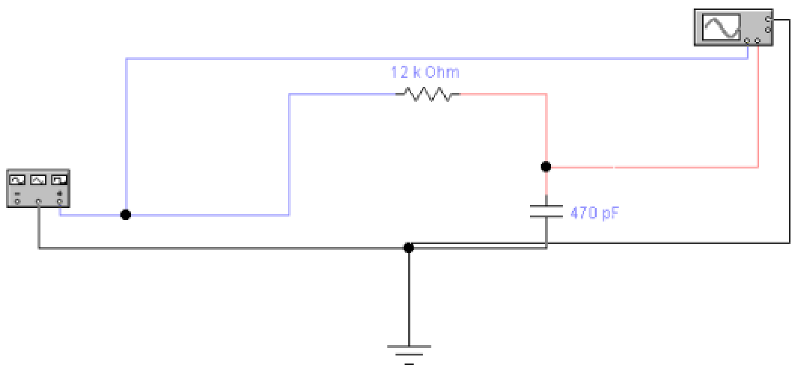
• $f = 400KHz$

$\Rightarrow$ experimental: $\begin{cases} U_1 = 2,2256\,V \\ U_2 = 2,7744\,V \end{cases}$

teoretic: $\begin{cases} x = 0,26 \\ U_{1,2} = 2,5 \mp 2,5 \cdot \frac{1-e^{-0,26}}{1+e^{-0,26}} \simeq 2,5 \mp 0,32 \end{cases}$

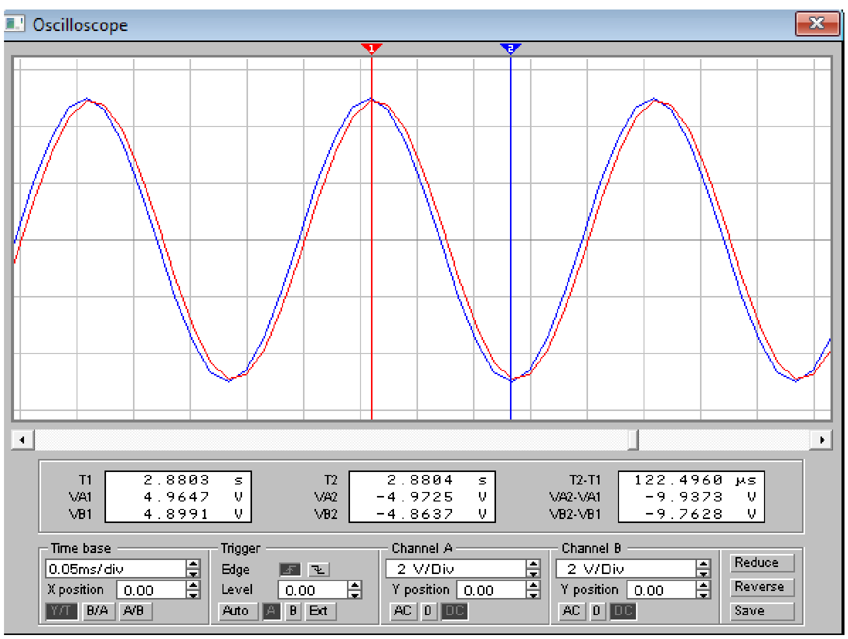
$\Rightarrow \begin{cases} U_1 = 2,18V \\ U_2 = 2,82V \end{cases}$

Circuitul simulat

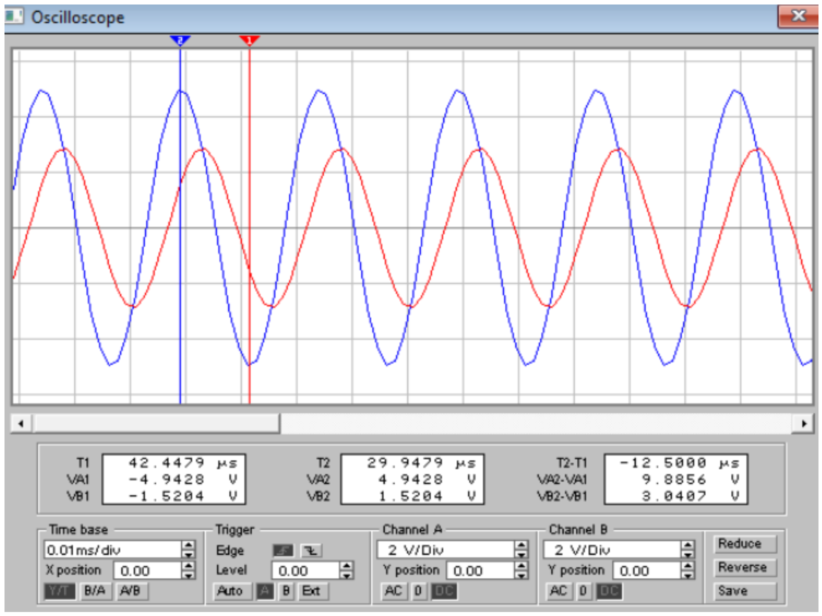


Semnalul sinusoidal

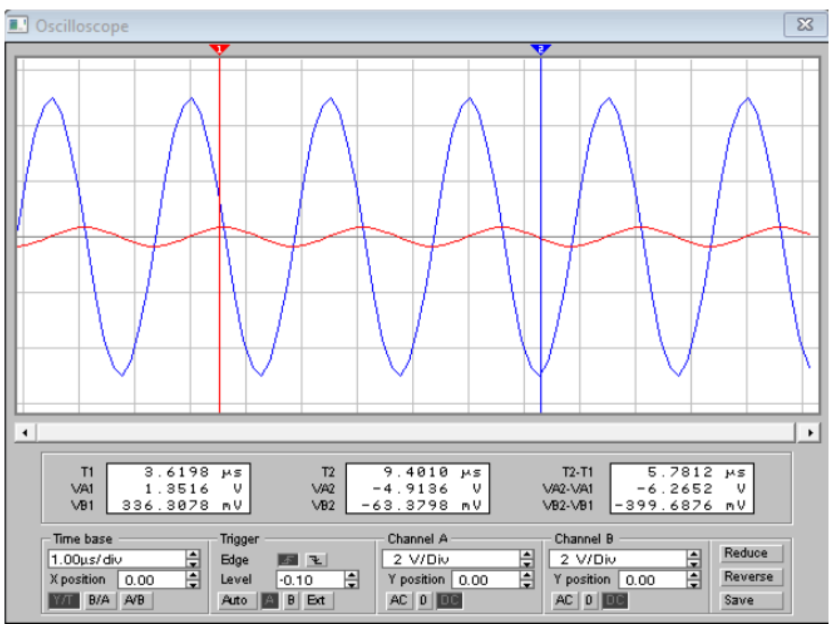
- f= 4kHz



- f = 40kHz

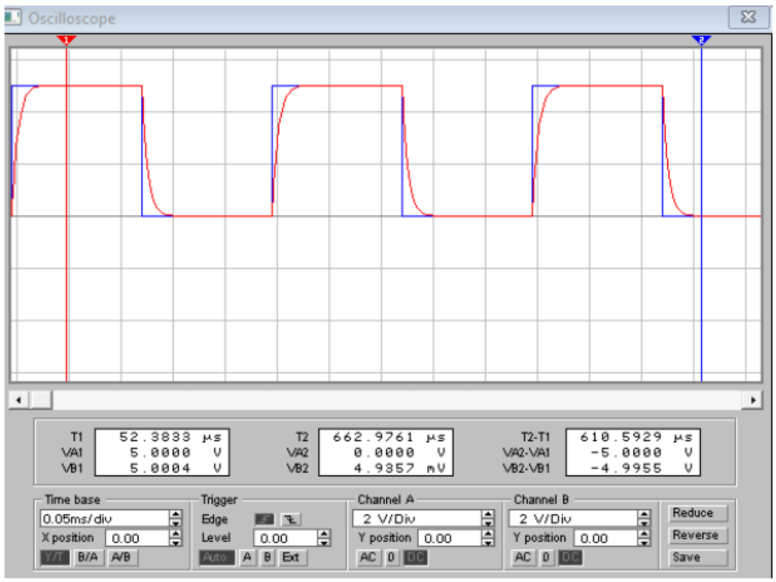


- f=400kHz

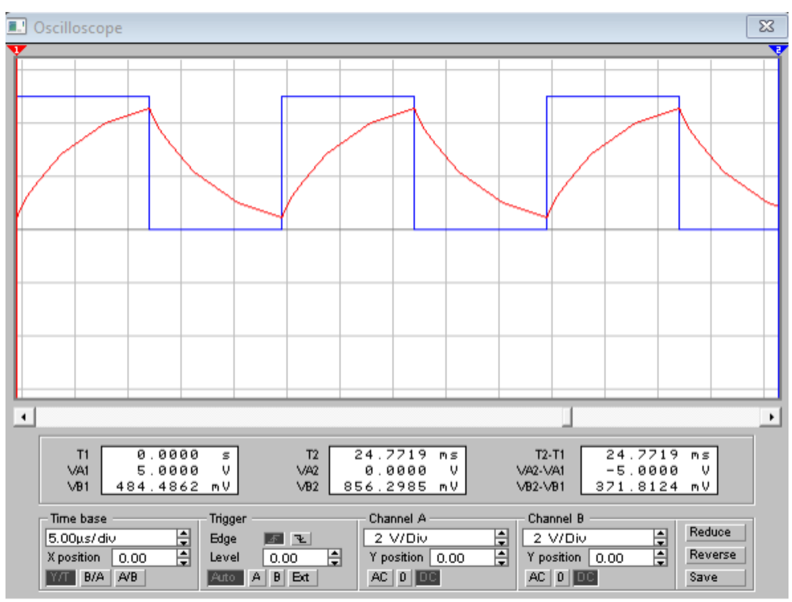


Semnalul rectangular

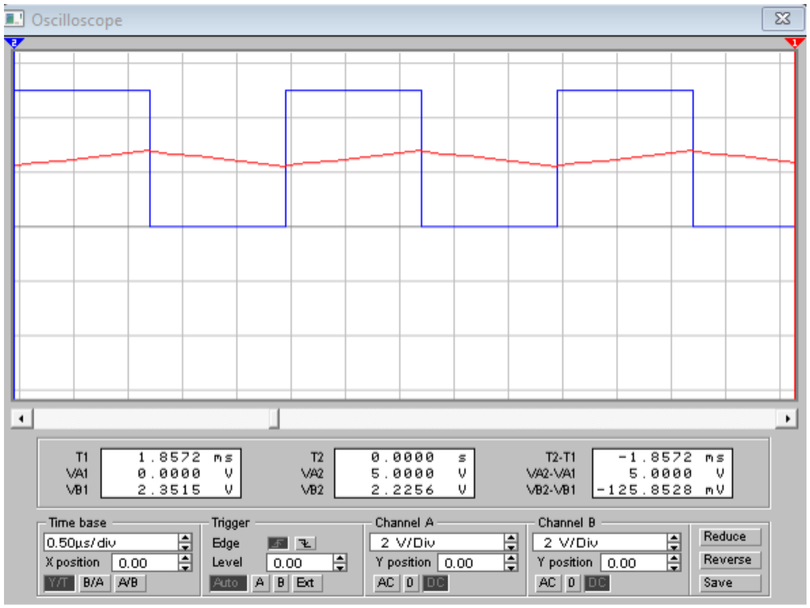
- f = 4kHz



- f = 40kHz



- f=400kHz


Oscilloscope
T1 1.8572 ms
VA1 0.0000 V
VB1 2.3515 V
T2 0.0000 s
VA2 5.0000 V
VB2 2.2256 V
T2-T1 -1.8572 ms
VA2-VA1 5.0000 V
VB2-VB1 -125.8528 mV
Time base
0.50µs/div
X position 0.00
Y/T B/A A/B
Trigger
Edge
Level 0.00
Auto A B Ext
Channel A
2 V/Div
Y position 0.00
AC 0 DC
Channel B
2 V/Div
Y position 0.00
AC 0 DC
Reduce
Reverse
Save