Lucrarea 1

Cortescu Radu
gr. 5.2, an 2

Circuite liniare RC trece-jos

1. Scopul lucrării

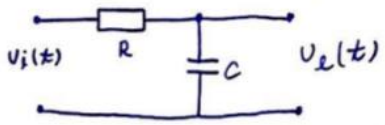
Se va studia experimental trecerea semnalelor de diferite forme - sinusoidale
- rectangulare
- exponențiale

prin circuitele RC trece-jos.

2. Considerații teoretice

- semnal sinusoidal la intrarea unui circuit liniar => formă sinusoidală
- semnal nesinusoidal => distorsiuni = "transformare liniară" a semnalelor
- Circuite liniare: - circuite cu elemente pasive: RC, LC, RLC
  - transformatoarele de impulsuri
  - linii de întârzieri
  - amplificatoare de impulsuri

2.1. Circuite RC trece-jos



- Dacă semnalul aplicat circuitului este nesinusoidal, componentele sale de frecvență joasă apar la ieșire cu o atenuare mai mică decât componentele de frecvență înaltă.

2.1.1. Semnalul de intrare sinusoidal de frecvență f:

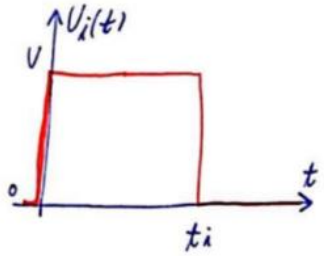
- atenuat cu raportul: $A(\omega) = \frac{1}{\sqrt{1+(\omega RC)^2}}$ $\quad A = \frac{U_e}{U_i}$
- defazat cu un unghi: $\varphi(\omega) = -\operatorname{arctg}(\omega RC)$

$\omega = 2\pi f$

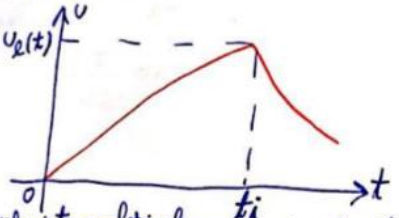
$\varphi = \frac{t \cdot 360^\circ}{T}$

2.1.2. Semnalul de intrare impuls

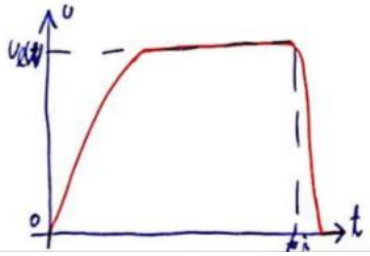
a) $RC = t_i$



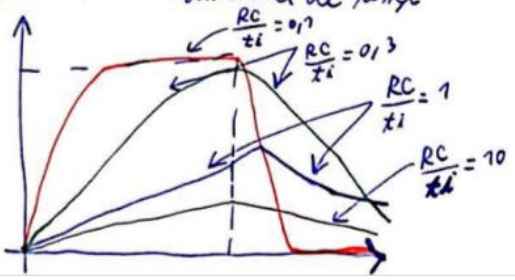
b) $RC < t_i$



c) $RC \ll t_i$

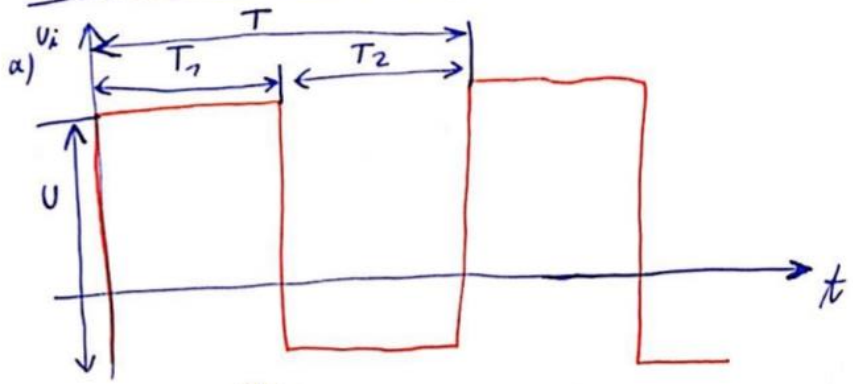


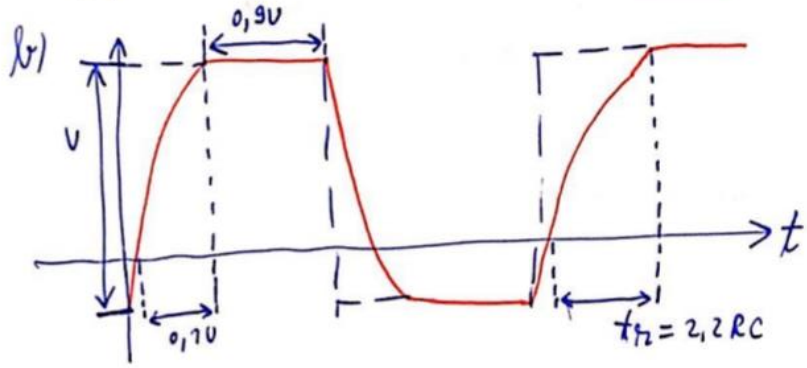
d) diferite valori ale constantei de timp



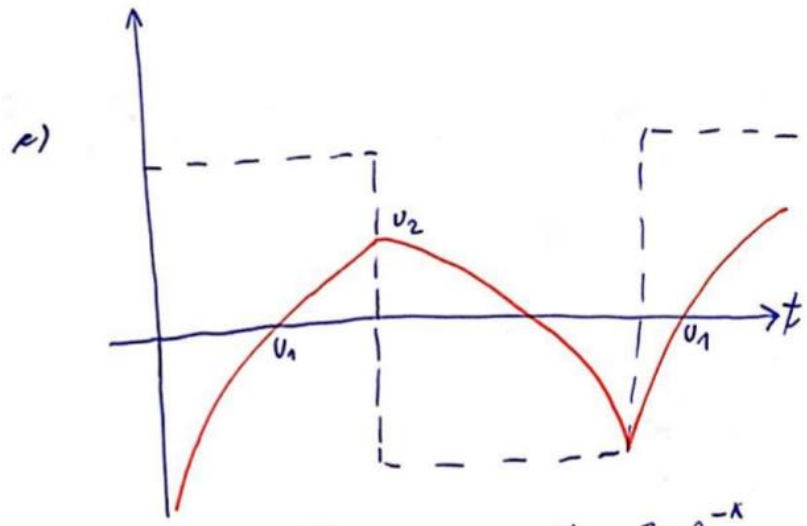
2.1.3 Semnal de intrare rectangular

Scortescu Radu
gr. 5.2





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



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

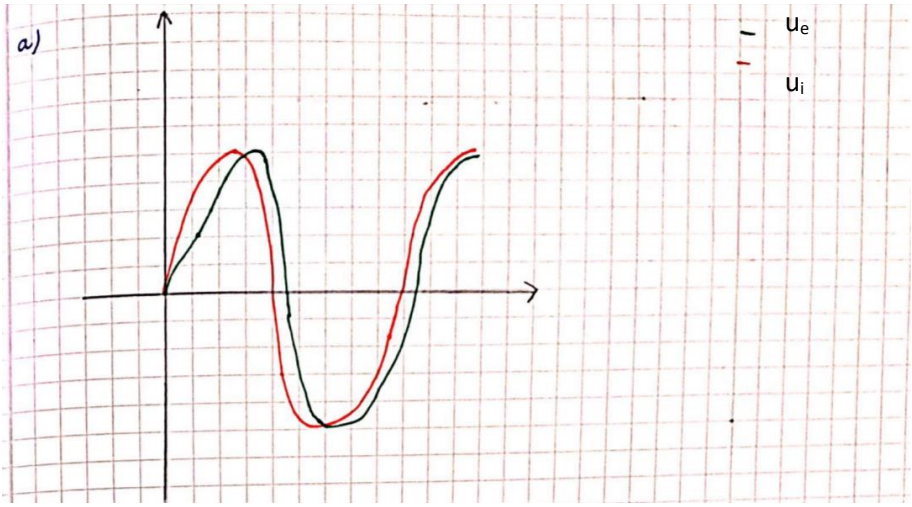
- Pentru $T_1 = T_2 = \frac{T}{2}$: $U_1 = -\frac{U}{2} \cdot \frac{1-e^{-x}}{1+e^{-x}}$

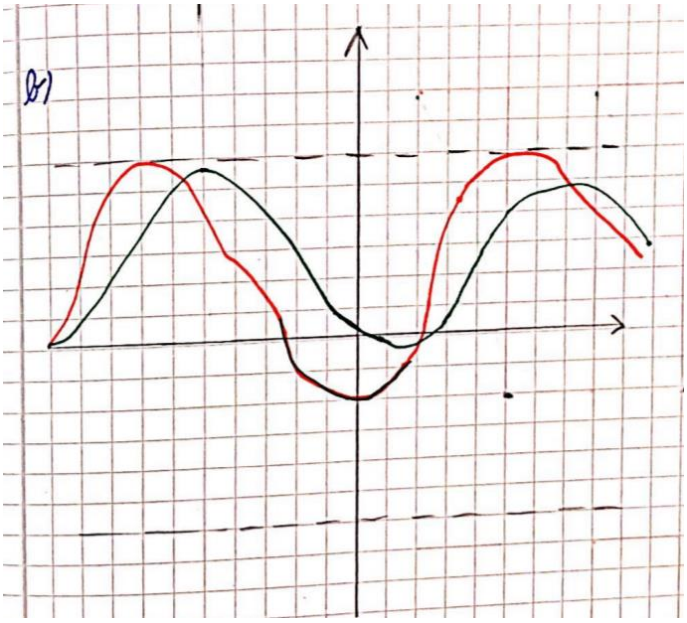
$$U_2 = \frac{U}{2} \cdot \frac{1-e^{-x}}{1+e^{-x}}$$

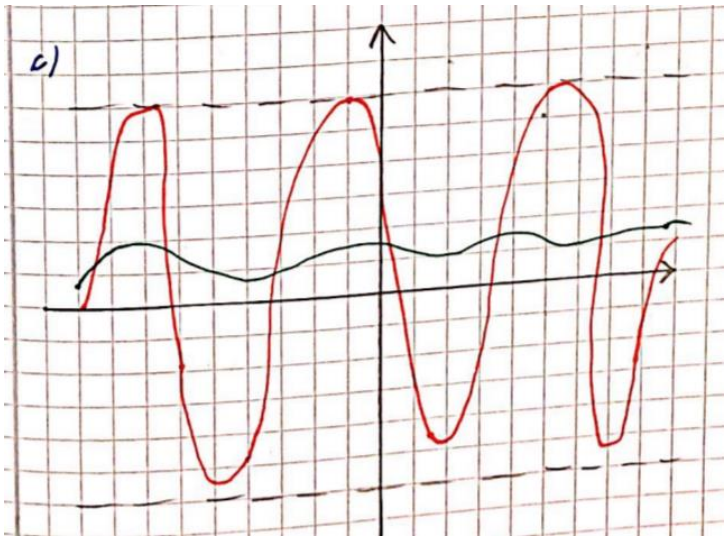
$$x = \frac{T}{2RC}$$

Reprezentarea semnalelor

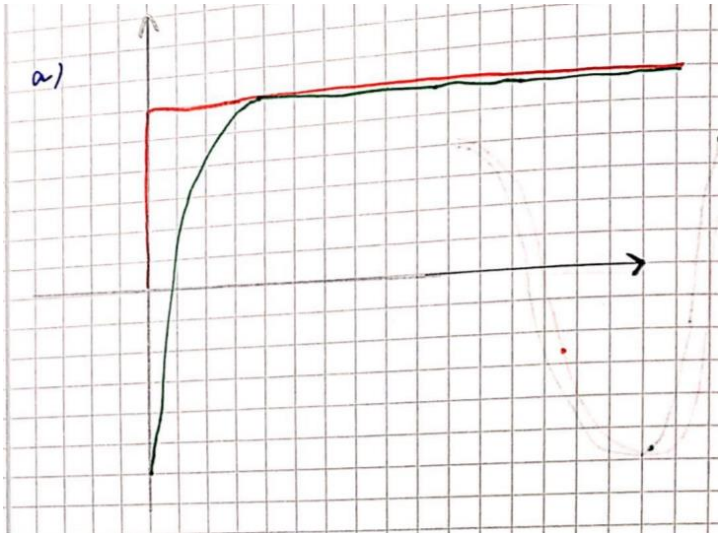
Sinusoidal

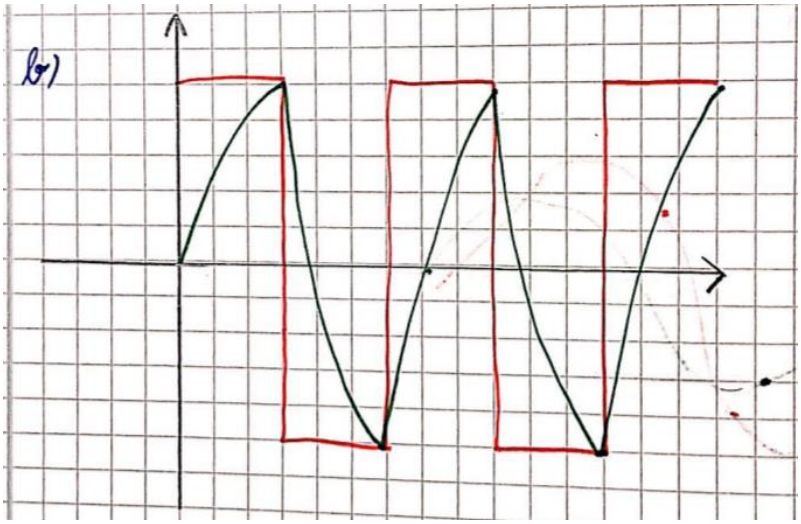


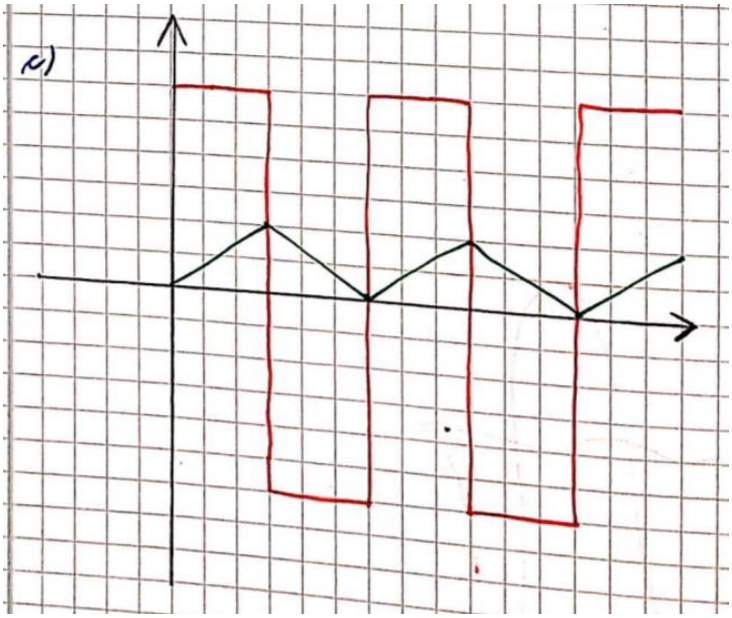




Rectangular







Calcule teoretice

3.1.1. $R = 12\,K\Omega = 12 \cdot 10^3\,\Omega$

$C = 470\,nF = 470 \cdot 10^{-12}\,F$

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

$\omega_1 = 2\pi f_1 = \pi \cdot 8 \cdot 10^3\,rad/s$

$A(\omega_1) \overset{(1.1)}{=} \frac{1}{\sqrt{1+(\omega_1 RC)^2}} = \frac{1}{\sqrt{1+(8\cdot 10^3 \cdot \pi \cdot 12\cdot 10^3 \cdot 470\cdot 10^{-12})^2}} = \frac{1}{\sqrt{1+(45120\pi \cdot 10^{-6})^2}} =$

$= \frac{1}{\sqrt{1+(141767,8\cdot 10^{-6})^2}} = \frac{1}{\sqrt{1+0,02007}} \simeq 1$

$\varphi = \frac{t \cdot 360^\circ}{T} \qquad = 2,4 \cdot 10^{-6}$

$\varphi = \frac{t \cdot 360^\circ}{T} \qquad t = 2,4 \cdot 10^{-6}\,s\,,\ T = \frac{1}{f} = \frac{1}{4\cdot 10^3} = 0,25 \cdot 10^{-3}$

$\varphi = \frac{2,4 \cdot 10^{-6} \cdot 360}{0,25 \cdot 10^{-3}} = \frac{2,4 \cdot 10^{-2} \cdot 36}{0,25} = 3,456^\circ$

b) $f_2 = 4 \cdot 10^4\,Hz$

$\varphi = \frac{t \cdot 360^\circ}{T}\,, \quad t = 4,3 \cdot 10^{-6}\,s\,,\ T = \frac{1}{4\cdot 10^4} = 0,25 \cdot 10^{-4}$

$\varphi = \frac{4,3 \cdot 10^{-5} \cdot 36}{0,25 \cdot 10^{-4}} = \frac{4,3 \cdot 36}{0,25} \cdot 10^{-1} = 67,9^\circ$

$A(\omega_2) = \frac{1}{\sqrt{1+(\pi \cdot 8 \cdot 10^4 \cdot 12 \cdot 10^3 \cdot 470 \cdot 10^{-12})^2}} = \frac{1}{\sqrt{1+(\pi \cdot 4512 \cdot 10^{-4})^2}} = \frac{1}{\sqrt{1+(1,4176)^2}} =$

$= \frac{1}{\sqrt{1+2,005}} = \frac{1}{1,733} = 0,577$

c) $t = 673,077 \cdot 10^{-9}\,,\ T = \frac{1}{4\cdot 10^5} = 0,25 \cdot 10^{-5}\,,\ \omega_3 = \pi \cdot 8 \cdot 10^5\,rad/s$

$\varphi = \frac{673,077 \cdot 10^{-9} \cdot 36}{0,25 \cdot 10^{-5}} = 96,923^\circ$

$A(\omega_3) = \frac{1}{\sqrt{1+(\pi \cdot 8 \cdot 10^5 \cdot 12 \cdot 10^3 \cdot 47 \cdot 10^{-11})^2}} = \frac{1}{\sqrt{1+(\pi \cdot 4512 \cdot 10^{-2})^2}} = \frac{1}{\sqrt{1+(14,1767)^2}} =$

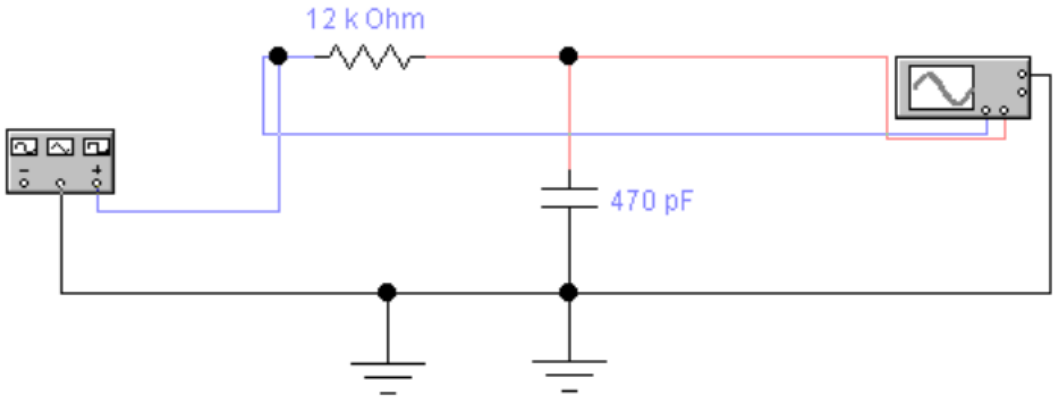
$= \frac{1}{\sqrt{1+200,17}} = \frac{1}{14,2} = 0,0704$

3.1.2

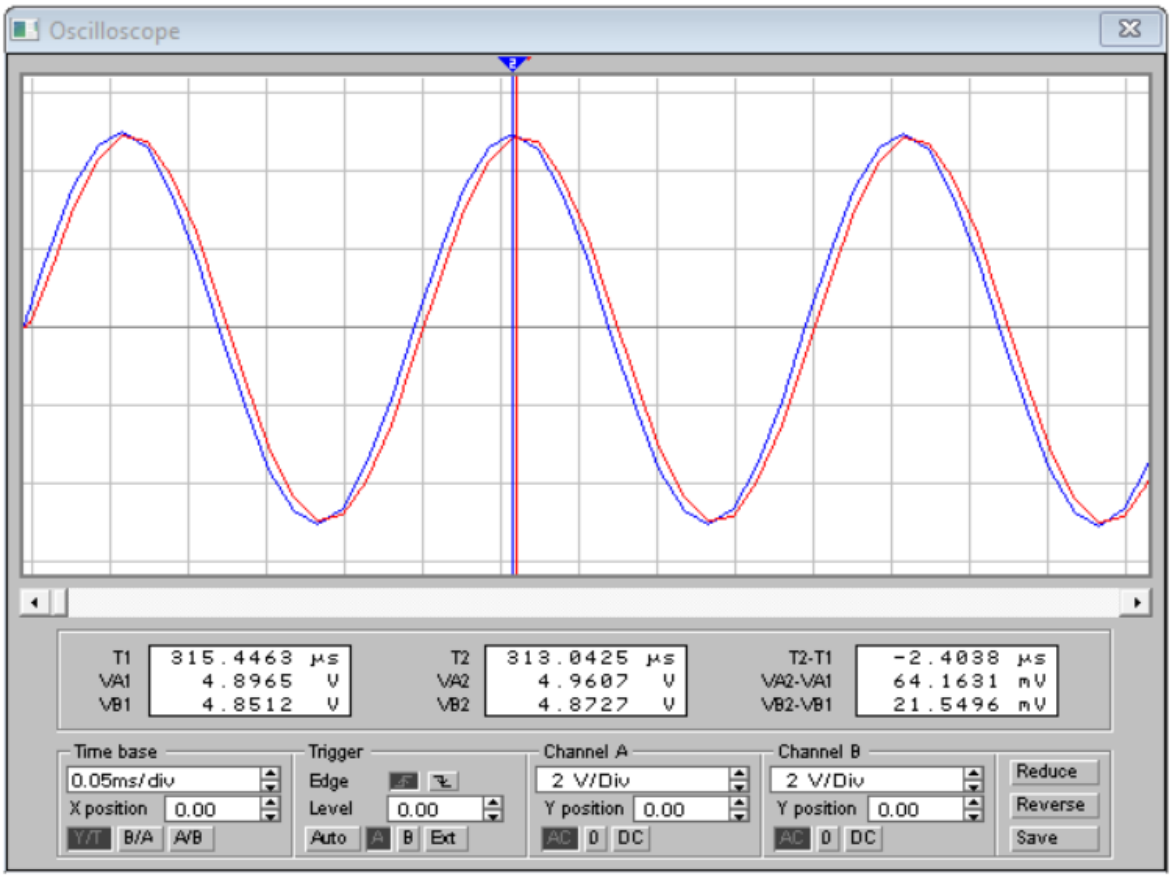
$f = 4 \cdot 10^3\,Hz$

$t_r = 2,2 \cdot R \cdot C = 2,2 \cdot 10^5 \cdot 47 \cdot 10^{-12} = 2,2 \cdot 47 \cdot 10^{-7} = 103,4 \cdot 10^{-7} = 10,34\,\mu s$

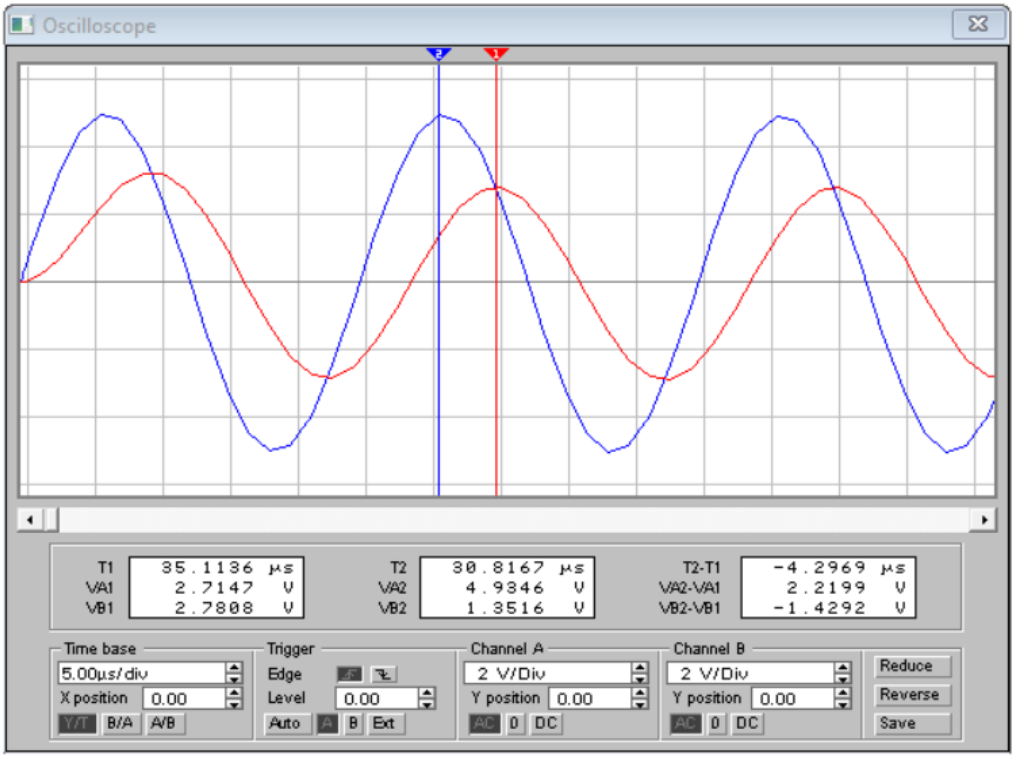
Simulare Electronic Workbench



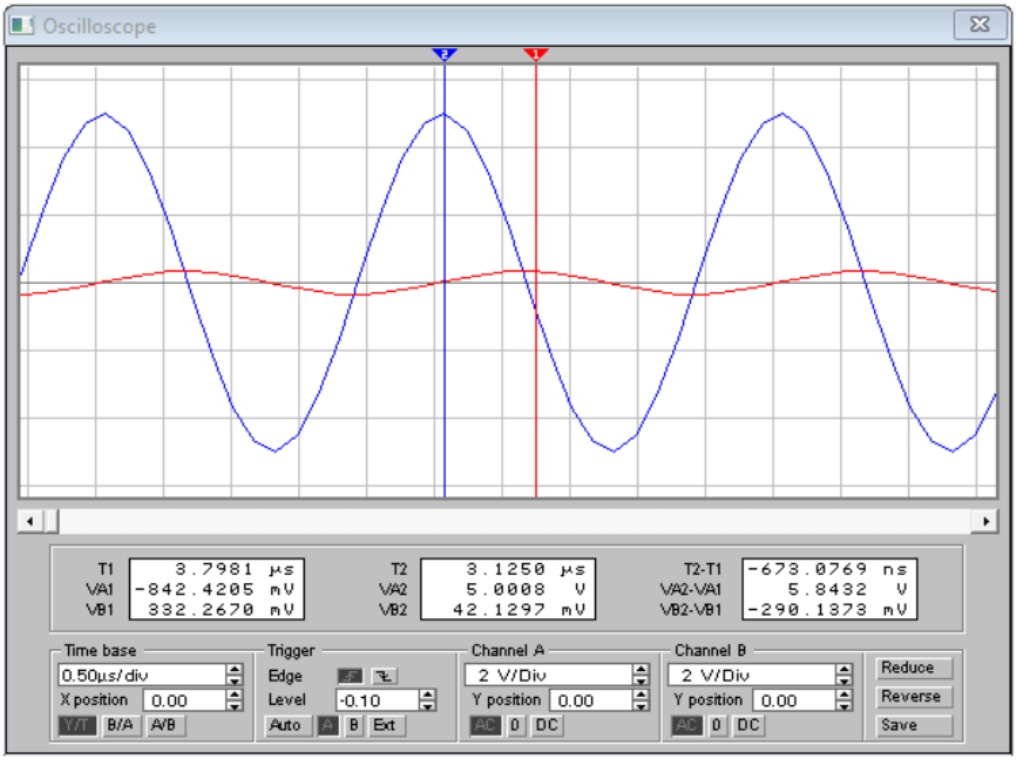
a) F1=4KΩ Defazaj: 2,4



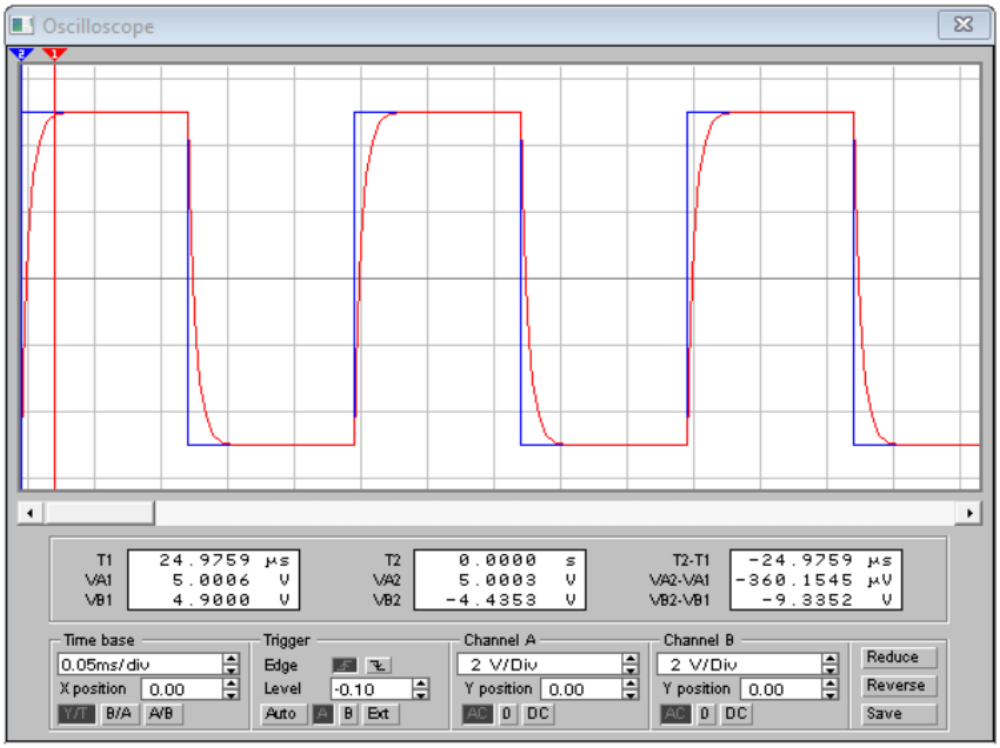
b) F1=40KΩ Defazaj: 4,3



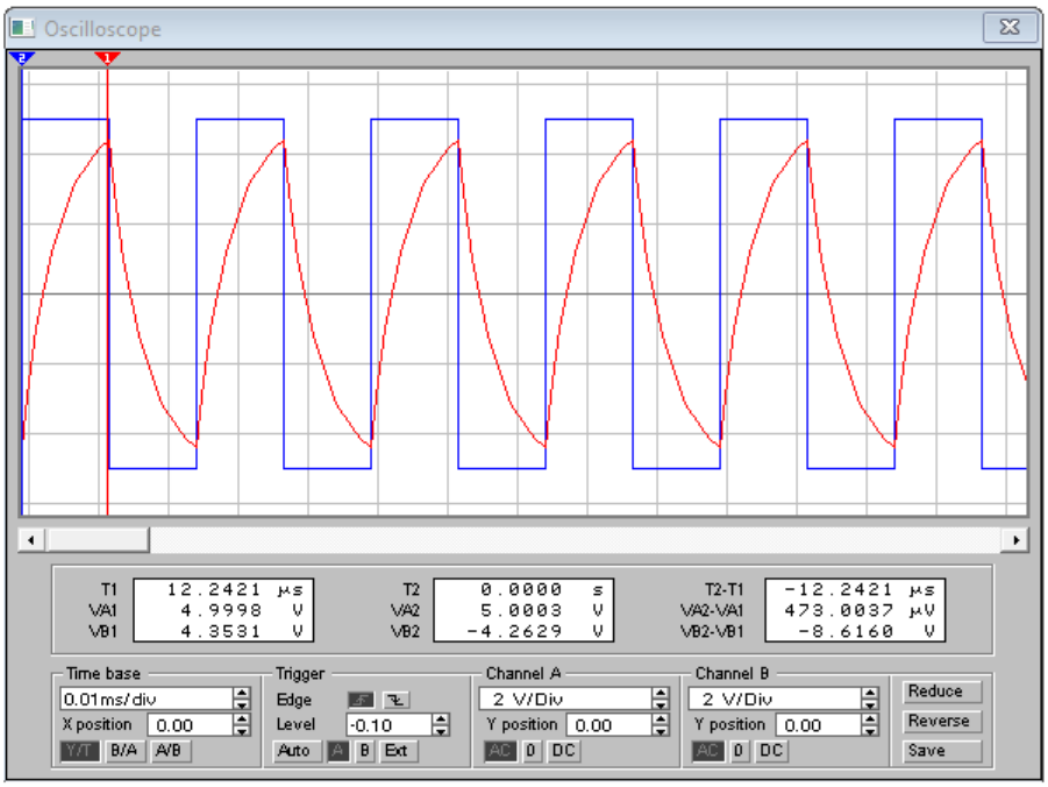
c) F1=400KΩ Defazaj: 673,077



a) F1=4KΩ Defazaj: 24,9



b) F1=40KΩ Defazaj: 12.,24



c) F1=400KΩ Defazaj: 1,22