

# Aplicația I

## Circuite digitale

### 1. Scopul lucrării:

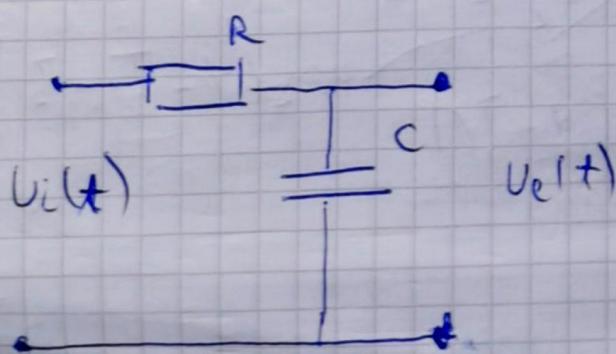
- este acela de a studia experimental trecerea semnalelor de diferite forme prin circuitul RC trece-jos

### 2 Considerații teoretice

- dacă se aplică semnal sinusoidal la intrarea unui circuit liniar  $\Rightarrow$  formă sinusoidală
- semnalurile nesinusoidale suferă distorsiuni când se transmit prin circuit liniare  $\Rightarrow$  fenomenul de „transformare liniară”.
- din categoria circuitelor liniare fac parte: circuite cu elemente pasive RC, LC, RLC; transformatoare de impulsuri, linii de întăriere, amplificatoare de impulsuri.

### 2.1. Circuite RC trece-jos

- permiță proprietatea de a avea atenuarea A în funcție de frecvența semnalului de intrare
- circuit nesinusoidal  $\Rightarrow$  componentele de frecvență joasă, ale sale, apăr la ieșire în o atenuare mai mică decât componentele de frecvență înaltă



$\rightarrow$  circuitul RC trece-jos

Fig. 1

## 2.1.1 Semnalul de intrare sinusoidal de frecvență

$$A(w) = \frac{1}{\sqrt{1 + (wRC)^2}} \quad (1.1)$$

$$A = \frac{U_E}{U_L} \quad (1.2)$$

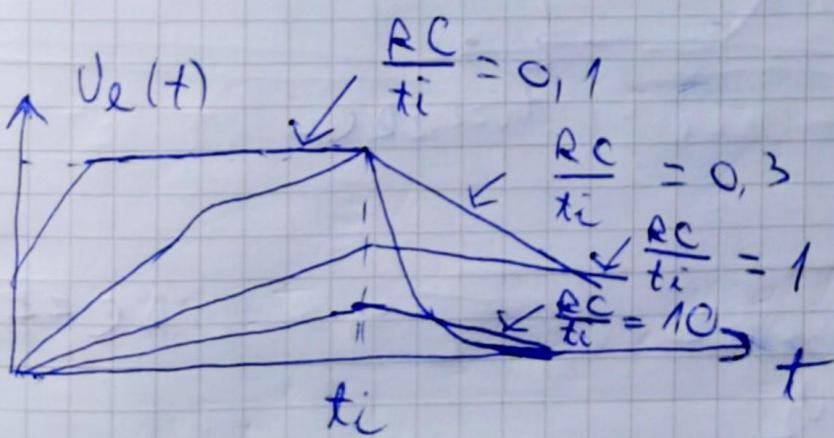
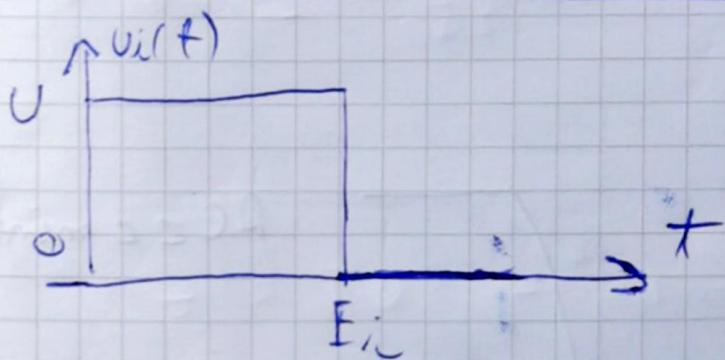
atenuare

$$\phi(w) = -\arctg(wRC) \text{ unde } w = 2\pi f \quad (2.1)$$

$$f = \frac{t \cdot 360^\circ}{T} \quad (2.2)$$

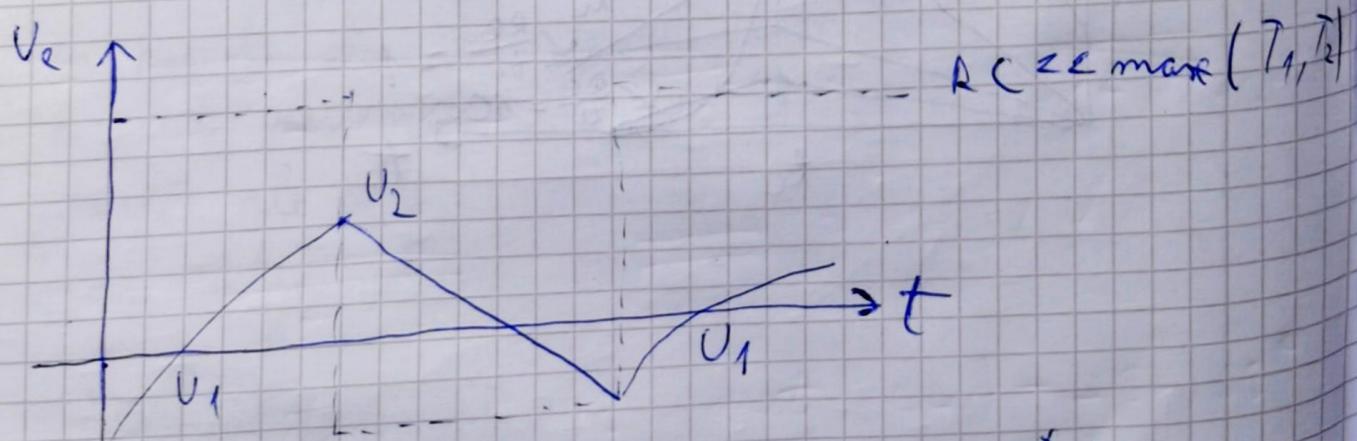
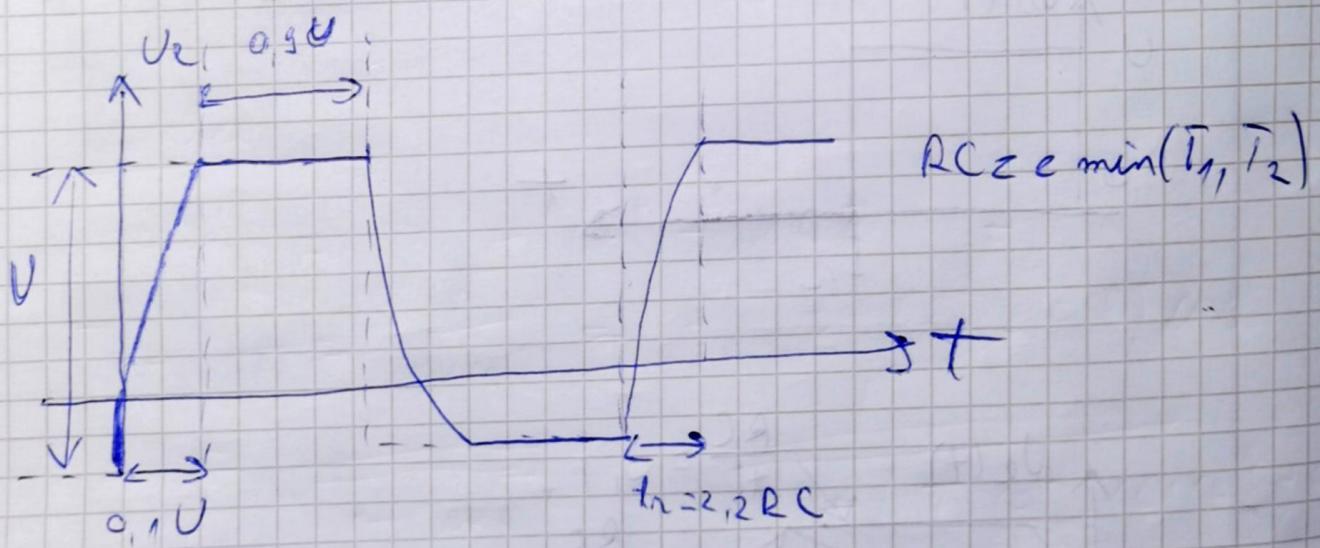
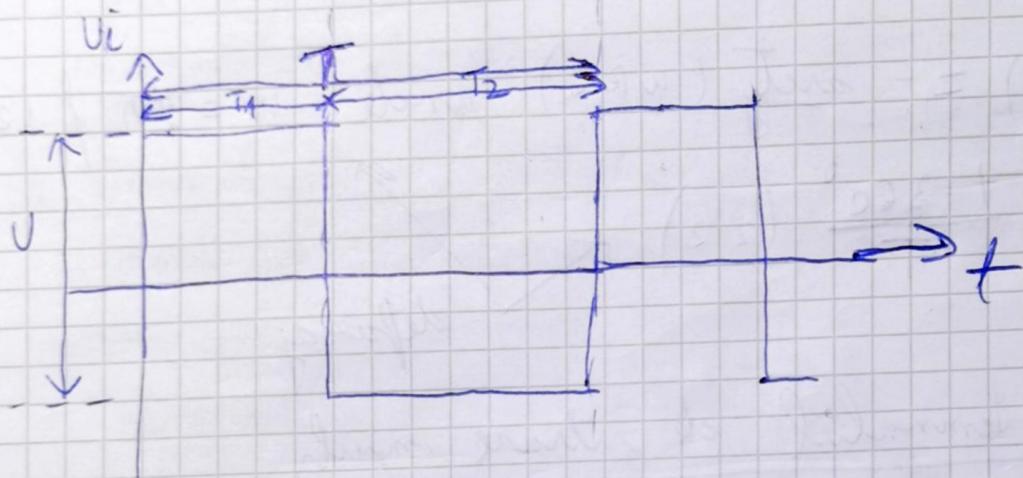
defazaj

## 2.1.2 Semnalul de intrare impuls



### 2.1.3 Semnal de intrare rectangular

- în următoarele figure este prezentat răspunsul circuitului pentru două valori extreme ale constantei de timp  $RC$



$$\text{Pf } T_1 = T_2 = \frac{T}{2} \Rightarrow U_1 = -\frac{U}{2} * \frac{1 - e^{-x}}{1 + e^{-x}}$$

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

semnal de intrare sinusoidal

a)  $f_1 = 4 \cdot 10^3 \text{ Hz} = 4 \text{ kHz}$

$R = 12 \Omega$

$C = 470 \text{ pF}$

Belcea Vlad

### Osciloscop

$$T = 250 \mu\text{s}$$

$$\left. \begin{array}{l} U_{\text{in}} = 9,96 \text{ V} \\ U_{\text{out}} = 9,8 \text{ V} \end{array} \right\} \Rightarrow t = \frac{U_{\text{out}}}{U_{\text{in}}} = 0,98 \text{ V}$$

$$t = 6,41 \mu\text{s}$$

$$\phi^\circ = \frac{t \cdot 360}{T} = \frac{6,41 \cdot 360}{250} = 9,23^\circ$$

### Teoretic

$$\omega = 2\pi f = 2\pi \cdot 4 \cdot 10^3 \text{ Hz} = 8\pi \text{ kHz} = 8\pi \cdot 10^3 \text{ rad/s}$$

$$A(\bar{\omega}) = \frac{1}{\sqrt{1 + (\omega RC)^2}} = \frac{1}{\sqrt{1 + (8\pi \cdot 10^3 \cdot 12 \cdot 10^3 \cdot 470 \cdot 10^{-12})^2}}$$

$$A(\bar{\omega}) = \frac{1}{\sqrt{1 + (4,512 \cdot 10^{-5})^2}} = \frac{1}{\sqrt{1 + (0,14)^2}} =$$

$$= \frac{1}{\sqrt{1 + 0,019}} = \frac{1}{1,019}$$

$$A(\omega) = \frac{1}{\sqrt{1 + (14,167,68 \cdot 10^{-5})^2}} = \frac{1}{\sqrt{1 + (0,14)^2}} =$$

$$= \frac{1}{\sqrt{1 + 0,019}} = \frac{1}{\sqrt{1,019}} = 0,99 \text{ V}$$

$$| = -\arctg (\text{WRC}) = -\arctg (0,14) = -7,96^\circ$$

$$t = \frac{T}{360} = \frac{7,96 \cdot 25 \mu s}{360} = 5,52 \mu s$$

b)  $f_1 = 4 \cdot 10^4 \text{ Hz}$

### Oscilloskop

$$T = 25 \mu s$$

$$\left. \begin{array}{l} U_{iW} = 9,88 \text{ V} \\ U_{eW} = 5,66 \text{ V} \end{array} \right\} \Rightarrow A = \frac{U_e}{U_i} = \frac{5,66}{9,88} = 0,58 \text{ V}$$

$$t = 3,9 \mu s$$

$$| = t \frac{360^\circ}{25} = \frac{3,9 \cdot 360}{25} = 56,16^\circ$$

### Theorie

$$\omega = 2\pi f = 2\pi \cdot 4 \cdot 10^4 = 80\pi \text{ kHz}$$

$$T = \frac{1}{f} = \frac{1}{4 \cdot 10^4} = 0,000025 \text{ s} = 25 \mu s$$

$$A(\omega) = \frac{1}{\sqrt{1 + (\text{WRC})^2}} = \frac{1}{\sqrt{1 + (8\pi \cdot 10^4 \cdot 12 \cdot 10^3 \cdot 4 \cdot 10^{-12})^2}}$$

$$= \frac{1}{\sqrt{1 + (14167,68 \cdot 10^{-4})^2}} = \frac{1}{\sqrt{1 + (1,41)^2}} =$$

$$= \frac{1}{\sqrt{1 + 1,98}} = \frac{1}{\sqrt{2,98}} = 0,58 \text{ V}$$

$$| = -\arctg (\text{WRC}) = -\arctg (1,41) = -54,65^\circ$$

$$t = \frac{T}{360} = \frac{54,65 \cdot 25 \mu s}{360} = 3,8 \mu s$$

$$f_3 = 4 \cdot 10^5 \text{ Hz}$$

Belina Vlad

### Oscilloskop

$$T = 2,5 \mu\text{s}$$

$$\left. \begin{array}{l} U_{i\omega} = 9,58 \text{ V} \\ U_{o\omega} = 0,744 \text{ V} \end{array} \right\} \rightarrow A = \frac{U_{o\omega}}{U_{i\omega}} = \frac{0,744}{9,58} = 0,075 \text{ V}$$

$$t = 0,781 \mu\text{s}$$

$$p = \frac{t \cdot 360}{2,5} = \frac{0,781 \cdot 360}{2,5} = 112,464^\circ$$

### Theorie

$$\omega = 2\pi f = 2\pi \cdot 4 \cdot 10^5 \text{ Hz} = 8 \cdot 10^5 \pi \text{ rad/s}$$

$$T = \frac{1}{p} = \frac{1}{4 \cdot 10^5} = 0,0000025 \text{ s} = 2,5 \mu\text{s}$$

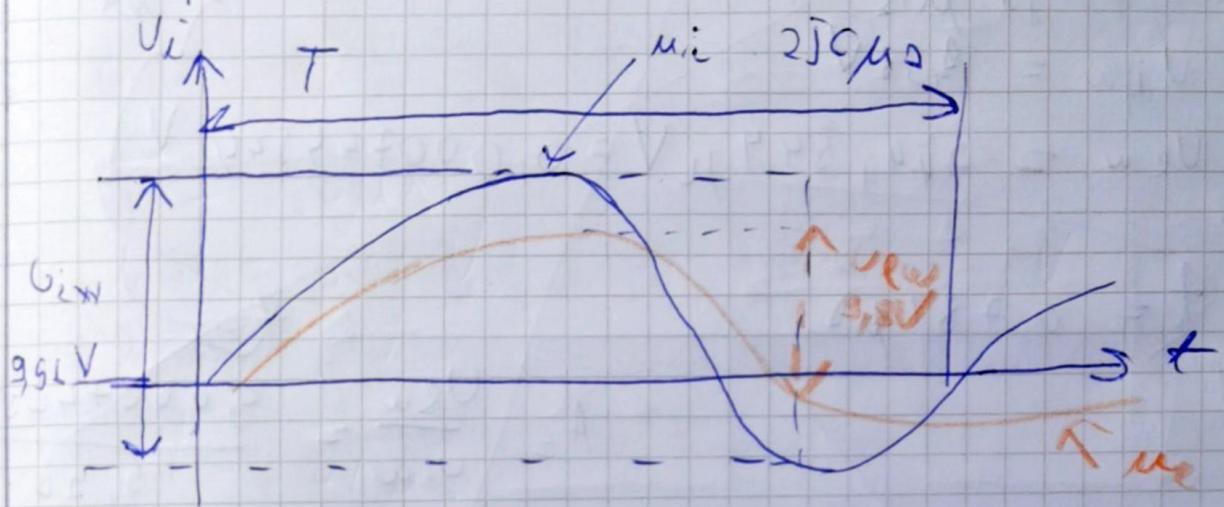
$$\begin{aligned} A(\omega) &= \sqrt{1 + (\omega_{2\pi})^2} = \sqrt{1 + (18\pi \cdot 10^5 \cdot 12 \cdot 10^3 \cdot 4 \cdot 10^{-4})^2} \\ &= \frac{1}{\sqrt{1 + (14,17)^2}} = \frac{1}{\sqrt{1 + (14,17)^2}} = \\ &= \frac{1}{\sqrt{1 + 200,79}} = \frac{1}{\sqrt{201,79}} = 0,02 \text{ V} \end{aligned}$$

$$\varphi = -\arctg(\omega A C) = -\arctg(14,17) = -80^\circ$$

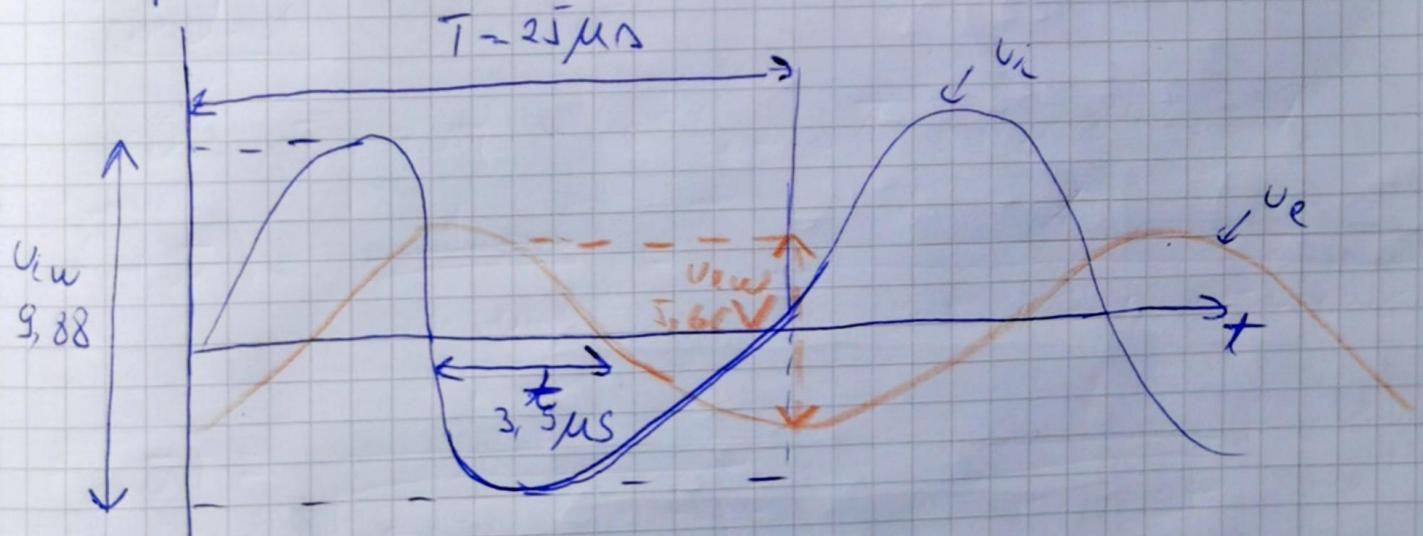
$$t = \frac{17}{360^\circ} = \frac{86 \cdot 2,5}{360} = 0,597 \mu\text{s}$$

b) Grafogramele tensiunilor de intrare  $U_i$  și de ieșire  $U_e$

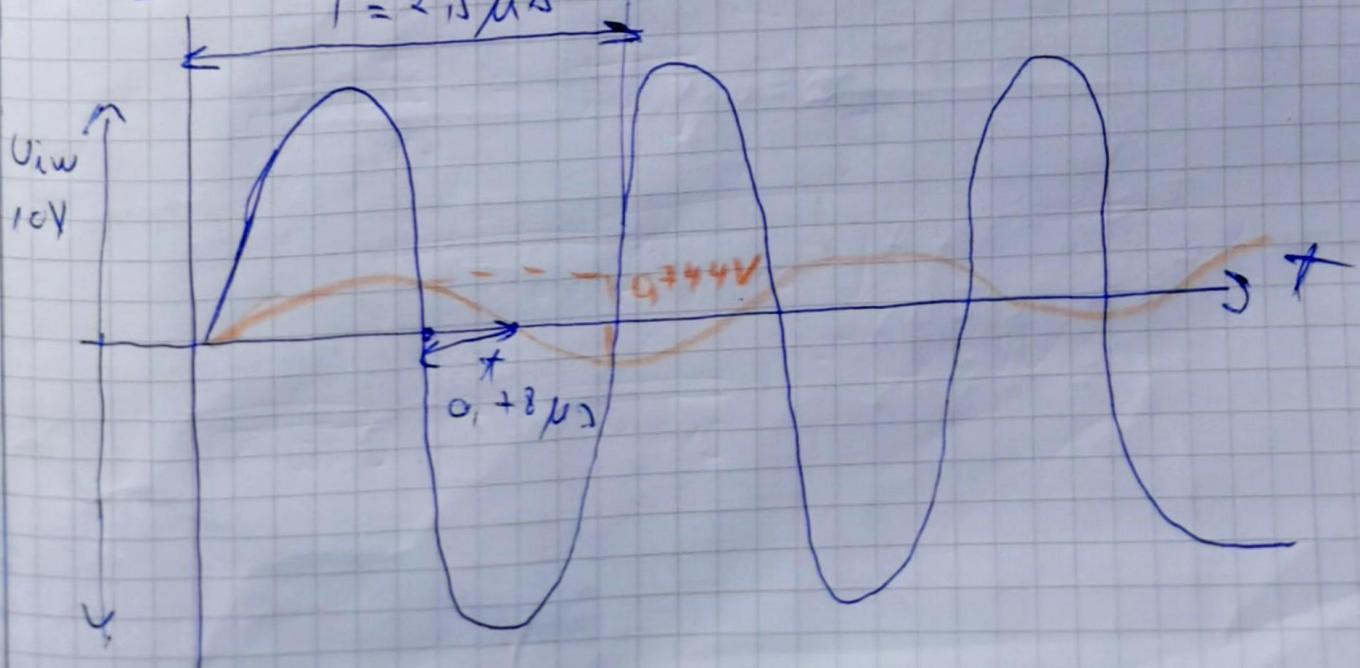
$$1. f_1 = 4 \cdot 10^3 \text{ Hz}$$



$$2 f_2 = 4 \cdot 10^4 \text{ Hz}$$



$$3 R_3 = 4 \cdot 10^5 \text{ Hz}$$

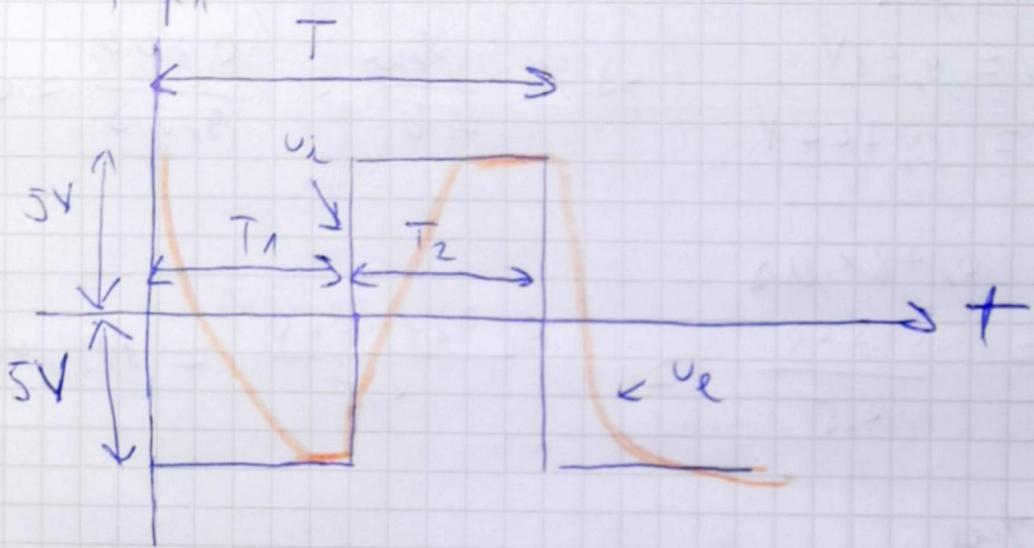


## Semnal de intrare rectangular

Beldea Ola

$$R = 10 \text{ k}\Omega, C = 470 \text{ }\mu\text{F}$$

a)  $f_1 = 4 \cdot 10^3 \text{ Hz}$



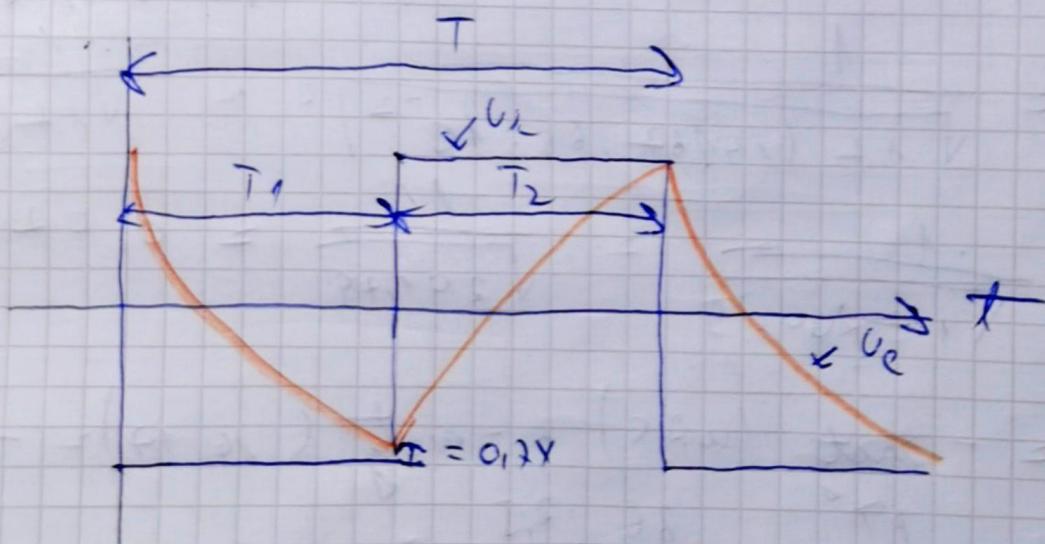
$$T = 250 \mu\text{s}$$

$$U = 10 \text{ V}$$

$$T_1 = 12,5 \mu\text{s}$$

$$T_2 = 12,5 \mu\text{s}$$

b)  $f_2 = 4 \cdot 10^4 \text{ Hz}$



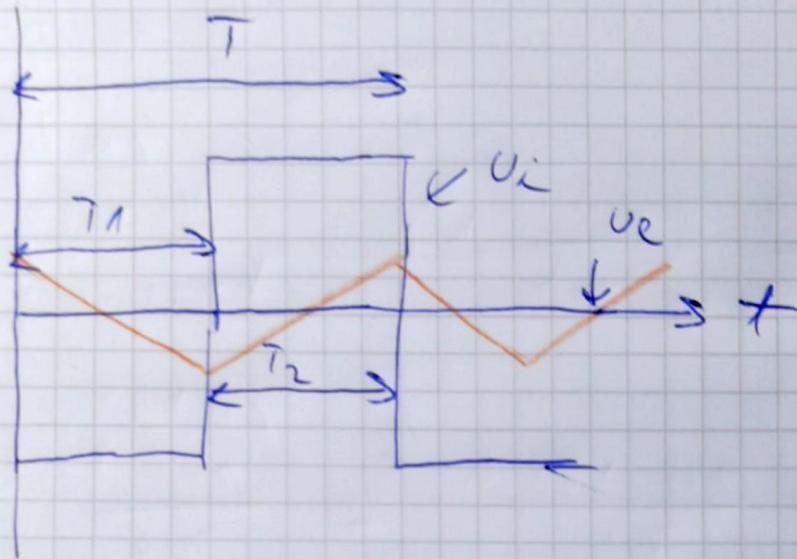
$$T = 25 \mu\text{s}$$

$$T_1 = 12,5 \mu\text{s}$$

$$T_2 = 12,5 \mu\text{s}$$

a)  $f = 4 \cdot 10^3 \text{ Hz}$

Beluca Vlad



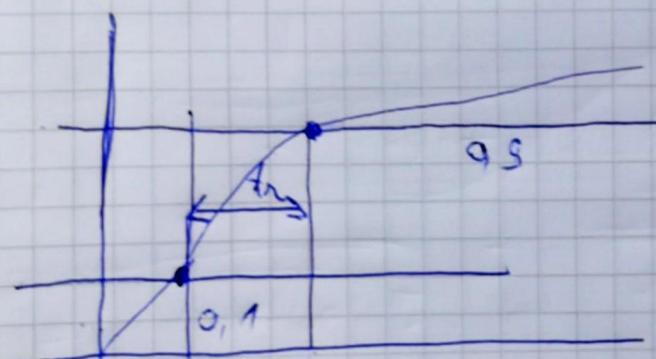
$$T = 2,5 \mu\text{s}$$

$$T_1 = 1,25 \mu\text{s}$$

$$T_2 = 1,25 \mu\text{s}$$

b) Măsurarea timpului de reducere pt  $\rho = f_1$

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



$$U = 10 \text{ V}, T = 250 \mu\text{s}, T_1 = 125 \mu\text{s}, T_2 = 125 \mu\text{s}$$

$$t_n = 12,31 \mu\text{s} \text{ (din osciloscop)}$$

$$\begin{aligned} t_n &= 2,2 R C = 2,2 \cdot 10^3 \cdot 470 \cdot 10^{-12} = 22,47 \cdot 10^{-12} \\ &= 10,34 \mu\text{s} \approx 10 \mu\text{s} \text{ (teoretic)} \end{aligned}$$

