Circuits and Electronic Laboratory

Experiment #5

Purpose of Experiment

In this experiment we will see how RC, RL and RLC circuit works.

General Information

There are three basic, linear passive lumped analog circuit components: the resistor (R), the capacitor (C), and the inductor (L). These may be combined in the RC circuit, the RL circuit, the LC circuit, and the RLC circuit, with the acronyms indicating which components are used. These circuits, among them, exhibit a large number of important types of behaviour that are fun-damental to much of analog electronics. In particular, they are able to act as passive lters.

To specify the behavior of an electrical circuit as a function of time, the equations related to the circuit must be acquired and solved. Circuit equations, in their general form, include integrals, derivatives and algebraic relations.

Circuits can be grouped as rst order and second order circuits. First order circuits consist of a resistor with a capacitor or a inductor but not both. Second order circuits can be made from using both capacitor and inductor.

Let’s consider circuit depicted in Figure 1. Derivation of RC circuit equa-tions is as follows:

$$V_r = iR \tag{1}$$

$$V_c = \frac{q}{C} \tag{2}$$

$$i = \frac{d_q}{d_t} \tag{3}$$

$$V = \frac{d_q}{d_t} R + \frac{q}{C} \tag{4}$$

$$VC = \frac{dq}{dt}RC + q \tag{5}$$

$$VC \quad q = \frac{dq}{dt}RC \tag{6}$$

$$\frac{dt}{RC} = \frac{dq}{VC \quad q} \tag{7}$$

$$\int_0^t \frac{dt}{RC} = \int_0^q \frac{dq}{VC \quad q} \tag{8}$$

$$\frac{t}{RC} = \ln\left(\frac{VC \quad q}{VC}\right) \tag{9}$$

$$VCe^{\frac{t}{RC}} = VC \quad q \tag{10}$$

$$VC(1 \quad e^{\frac{t}{RC}}) = q \tag{11}$$

$$\frac{V}{R}e^{\frac{t}{RC}} = i \tag{12}$$

$$V_c = V(1 \quad e^{\frac{t}{RC}}) \tag{13}$$

$$V_r = Ve^{\frac{t}{RC}} \tag{14}$$

In equations (13) and (14) $\frac{t}{RC}$ is called time constant .
RL and RLC circuits equations can be derived similarly.

Part List

R = 330

C = 100uF

L=1H

Preparations Before Experiment

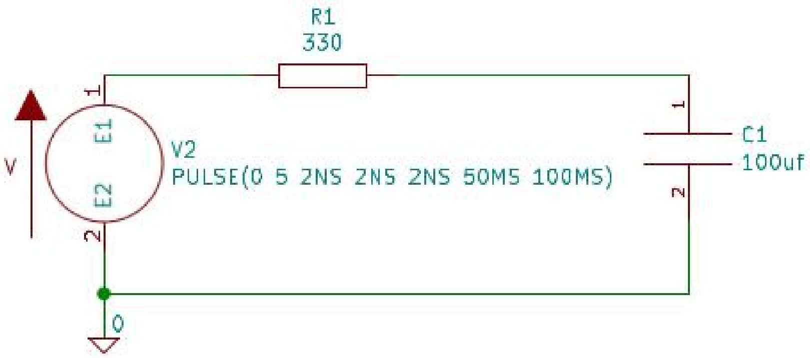
Revise time derivation of ln(f(x)) and $e^{f(x)}$f unctions

What is a capacitor and how it behaves?

What is an inductor and how it behaves?

Construct and analyze all circuits given in this document on a simula-tion program.

Figure 1: RC Circuit



Section 1

Construct the circuit depicted in Figure 1 on the board.

Use signal generator to generate V as -5V to 5V 10Hz square wave. Connect rst channel of oscillator to C_1

Calculate time constant = 0.033s

Calculate V_c = 2.822V at t = 0:05 using the equations derived above. Plot the V_c wave as seen on oscillator to Table 1.

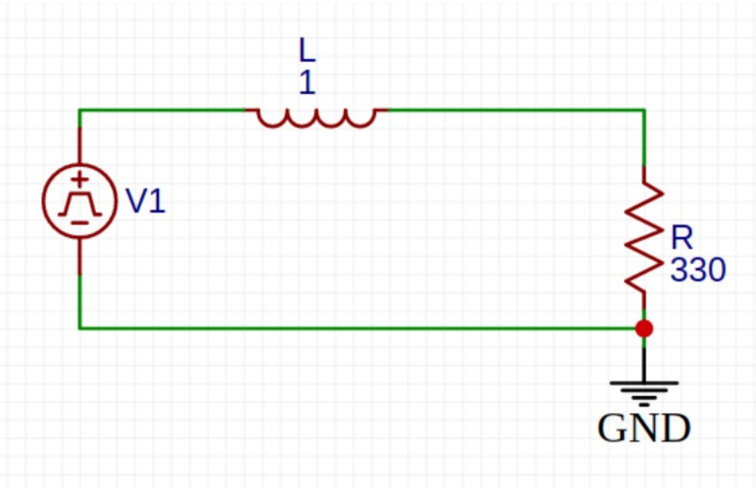


Table 1: V_C Plotted Using Experimental Data

Section 2

Construct the circuit depicted in Figure 2 on the board.

Use signal generator to generate V as -5V to 5V 10Hz square wave. Connect rst channel of oscillator to R_1

Calculate time constant = 0.033s

Plot the V_r wave as seen on oscillator to Table 2.

Table 2: V_r Plotted Using Experimental Data

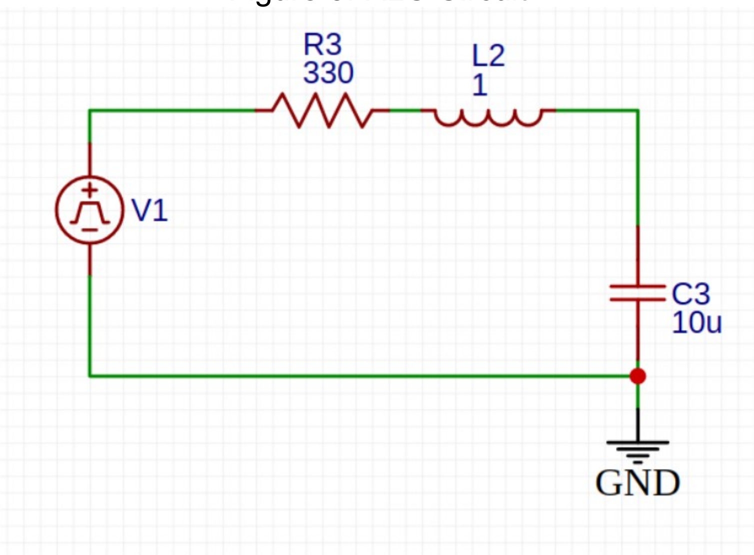
Section 3

Construct the circuit depicted in Figure 3 on the board.

Use signal generator to generate V as -5V to 5V 10Hz square wave. Connect rst channel of oscillator to C_3

Plot the V_c wave as seen on oscillator to Table 3.

Figure 3: RLC Circuit



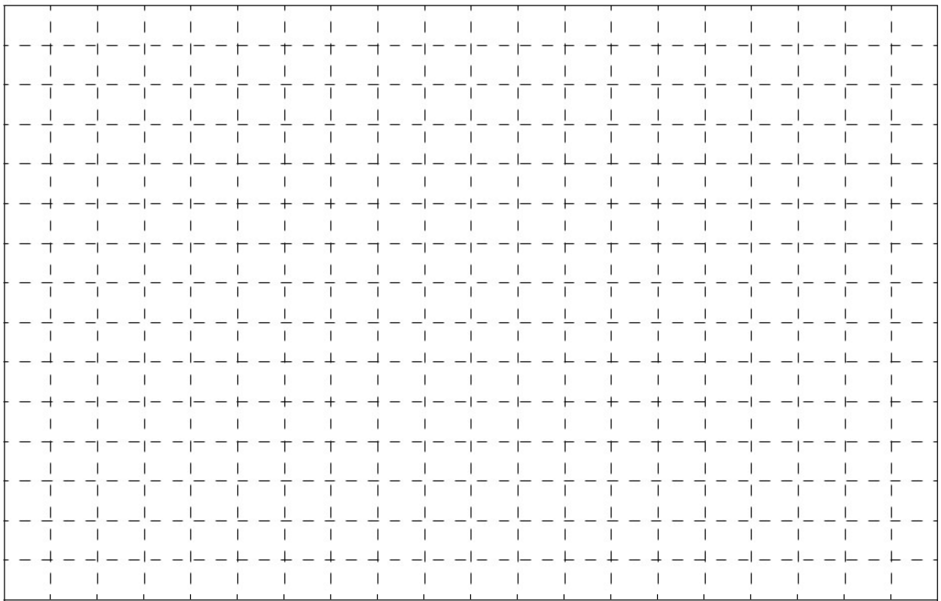
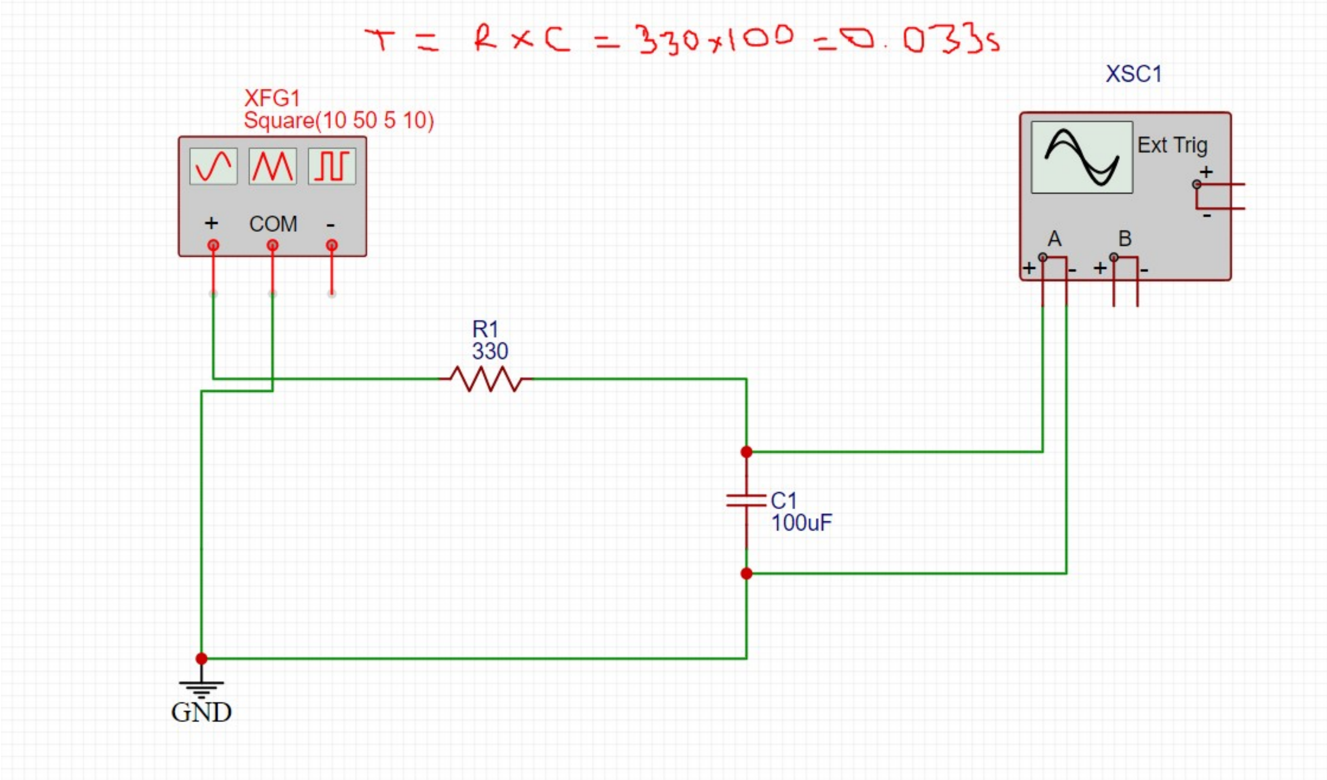
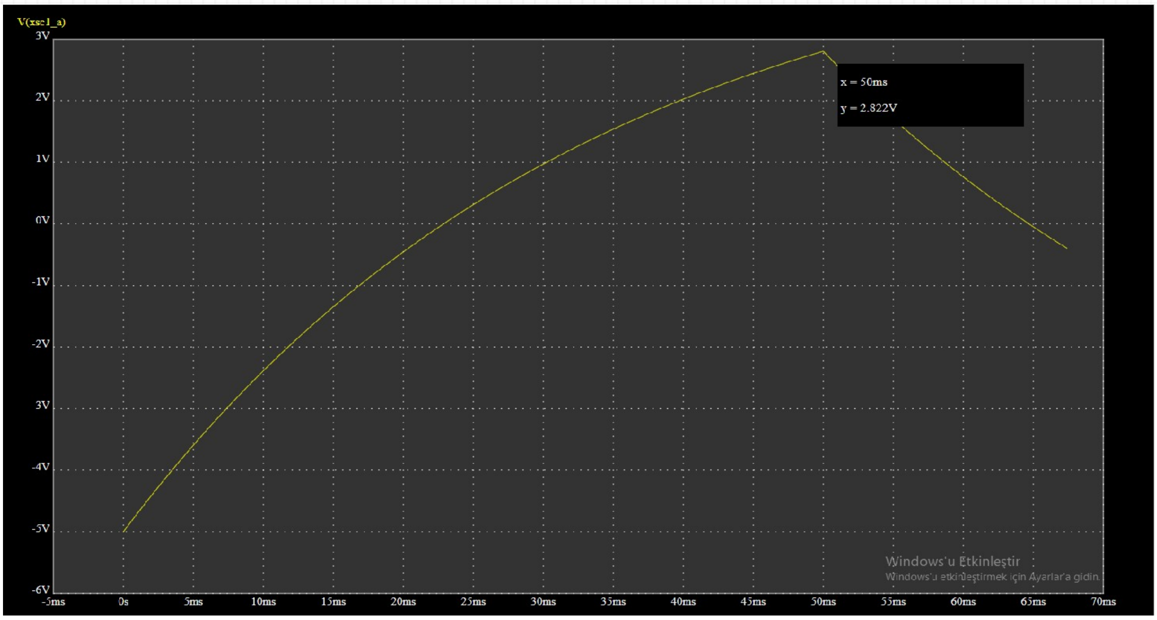


Table 3: V_C Plotted Using Experimental Data

TABLO 1

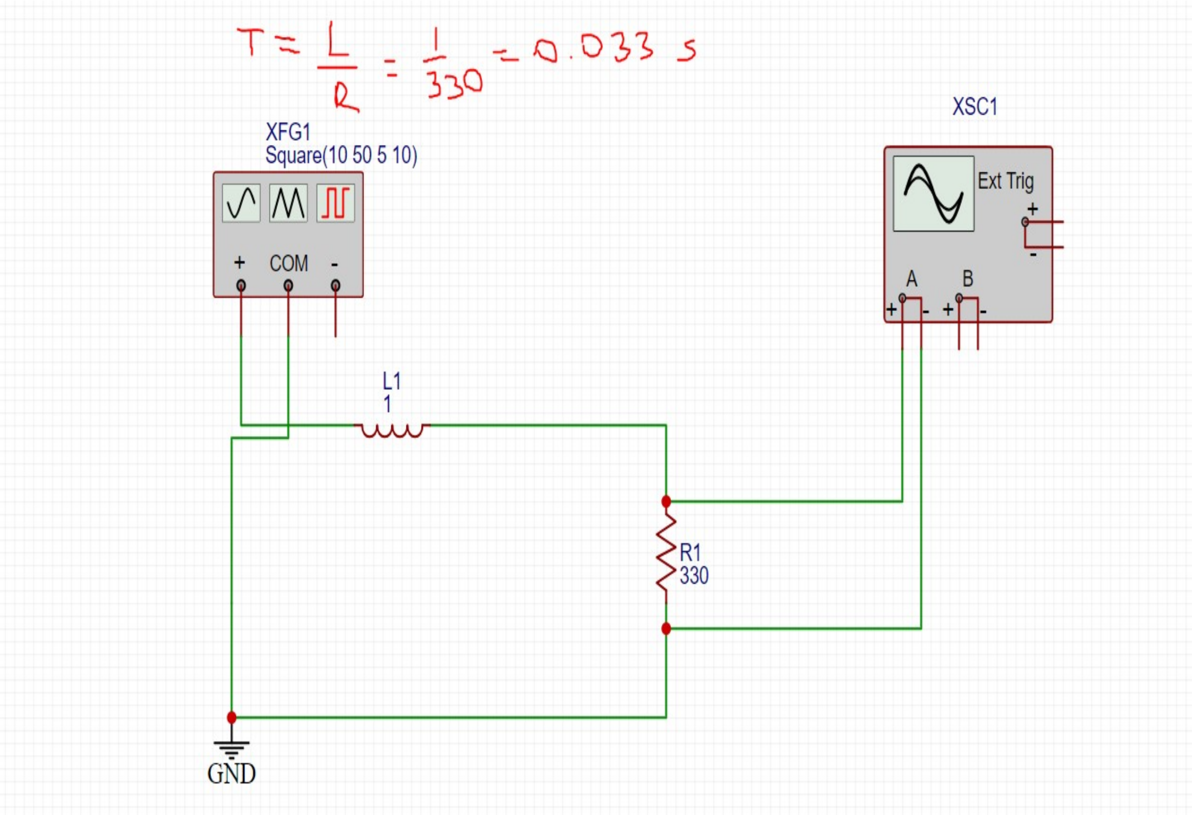


T = R x C = 330x100 = 0.033s
XSC1
XFG1
Square(10 50 5 10)
Ext Trig
+
COM
-
A
B
R1
330
C1
100uF
GND

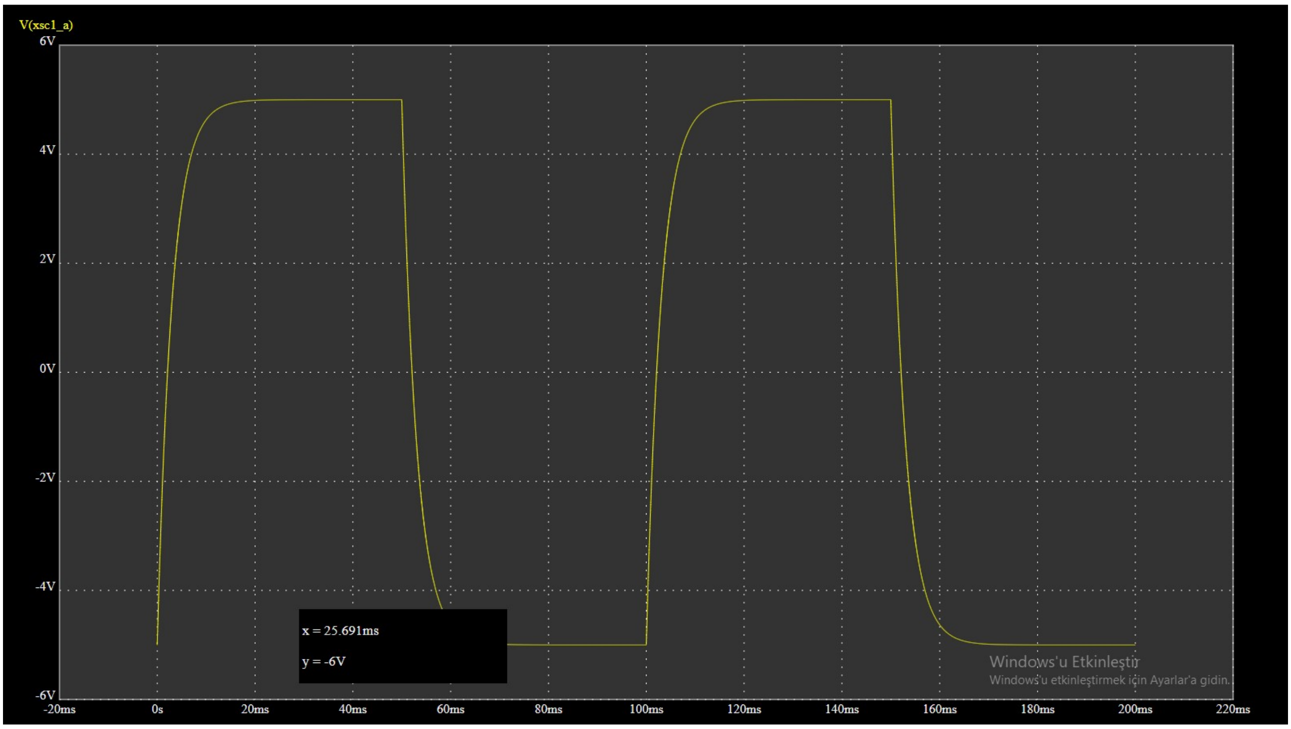


V(xsc1_a)
x = 50ms
y = 2.822V
3V
2V
1V
0V
-1V
-2V
3V
-4V
-5V
-6V
-5ms
0s
5ms
10ms
15ms
20ms
25ms
30ms
35ms
40ms
45ms
50ms
55ms
60ms
65ms
70ms
Windows'u Etkinleştir
Windows'u etkinleştirmek için Ayarlar'a gidin.

TABLE2

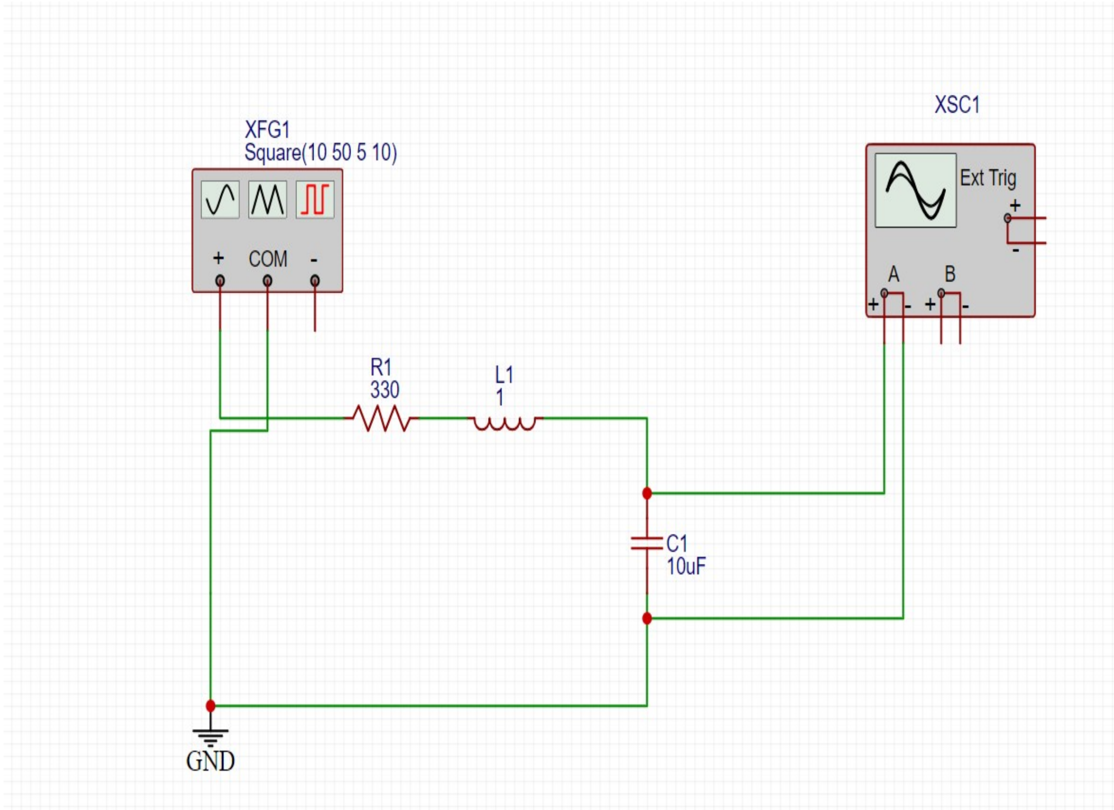


$T = \frac{L}{R} = \frac{1}{330} = 0.033\ s$
XFG1
Square(10 50 5 10)
+
COM
-
XSC1
Ext Trig
+
-
A
B
+
-
+
-
L1
1
R1
330
GND

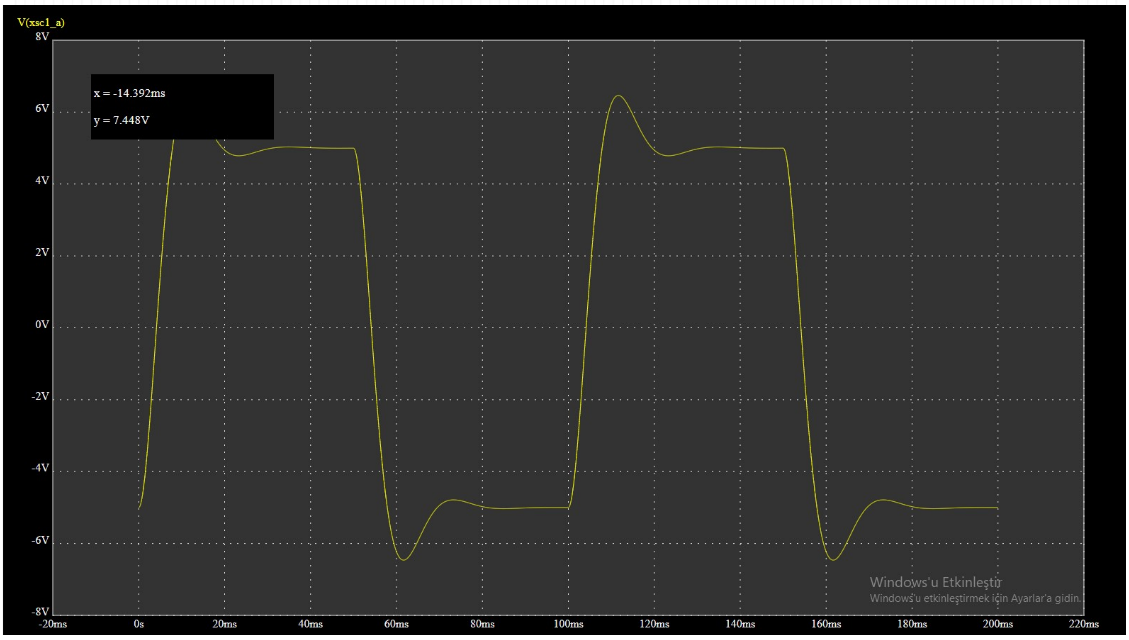


V(xsc1_a)
6V
4V
2V
0V
-2V
-4V
-6V
-20ms
0s
20ms
40ms
60ms
80ms
100ms
120ms
140ms
160ms
180ms
200ms
220ms
x = 25.691ms
y = -6V
Windows'u Etkinleştir
Windows'u etkinleştirmek için Ayarlar'a gidin.

TABLO 3



XFG1
Square(10 50 5 10)
+
COM
-
XSC1
Ext Trig
+
-
A
B
R1
330
L1
1
C1
10uF
GND



V(xsc1_a)
8V
6V
4V
2V
0V
-2V
-4V
-6V
-8V
x = -14.392ms
y = 7.448V
-20ms
0s
20ms
40ms
60ms
80ms
100ms
120ms
140ms
160ms
180ms
200ms
220ms
Windows'u Etkinleştir
Windows'u etkinleştirmek için Ayarlar'a gidin.