RC Circuit measurement

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Lab content

1. Set the voltage output from the function (signal generator) to be approximately 2V. (Use CRO)
2. Set the frequency of the function generator to 1 kHz (Use CRO)
3. Choose appropriate R and C values for the circuit.
4. Measure and record the peak values of VS, VR and VC in table 1.
5. Measure and record the time lag tR and tC, with the total voltage as a reference value, in table 1. Note whether this value is positive or negative.
6. Repeat the measurements at a frequency of 5 kHz and record the values in table 1.

Theory

An RC circuit is a basic circuit unit composed of a resistor R and a capacitor C , used for signal processing, filtering, time delay, etc.

1.Time Constantτ

The time constant describes the dynamic response of an RC circuit and is defined as: $\tau = R \times C$

2. Cutoff Frequencyf_c

For an RC filter, the cutoff frequency is the frequency where the circuit starts to significantly attenuate the signal, defined as:

$$f_c = \frac{1}{2\pi RC}$$

Low-pass filter:$f \leq f_c$will pass through, while signals with $f \geq f_c$will be attenuated. High-pass filter: $f \geq f_c$will pass through, while signals with$f \leq f_c$will be attenuated.

3.Impedance

In AC circuits, the total impedance of an RC circuit is the combination of the resistance R and the capacitive reactance X_C :

$$Z_T = Z_R + Z_C = R\angle 0\omega + X_C\angle - 90\omega = R - jX_C$$

4.Voltage-Related Parameters

4.1Power Supply Voltage $V_S

This is the input voltage provided to the circuit, typically supplied by a signal generator or a DC power source. V_S is a known external parameter. V_s is a known external parameter.

4.2Voltage Across the Resistor V_R

According to Ohm's law, the voltage across the resistor is:

$$V_R = I \cdot R$$

where I is the current in the circuit and R is the resistance.

4.3 Voltage Across the Capacitor V_C

The voltage across the capacitor depends on its charging or discharging state: During charging:

$$V_C(t) = V_S \cdot (1 - e^{\frac{-t}{\tau}})$$

During discharging:

$$V_C(t) = V_c0 \cdot e^{\frac{-t}{\tau}}$$

Here, $\tau = R \cdot C$ is the time constant, and v_C0 is the initial voltage.

Time Period T and Frequency f

If the circuit uses an AC power source, the time period and frequency are determined by the input signal: Time Period:

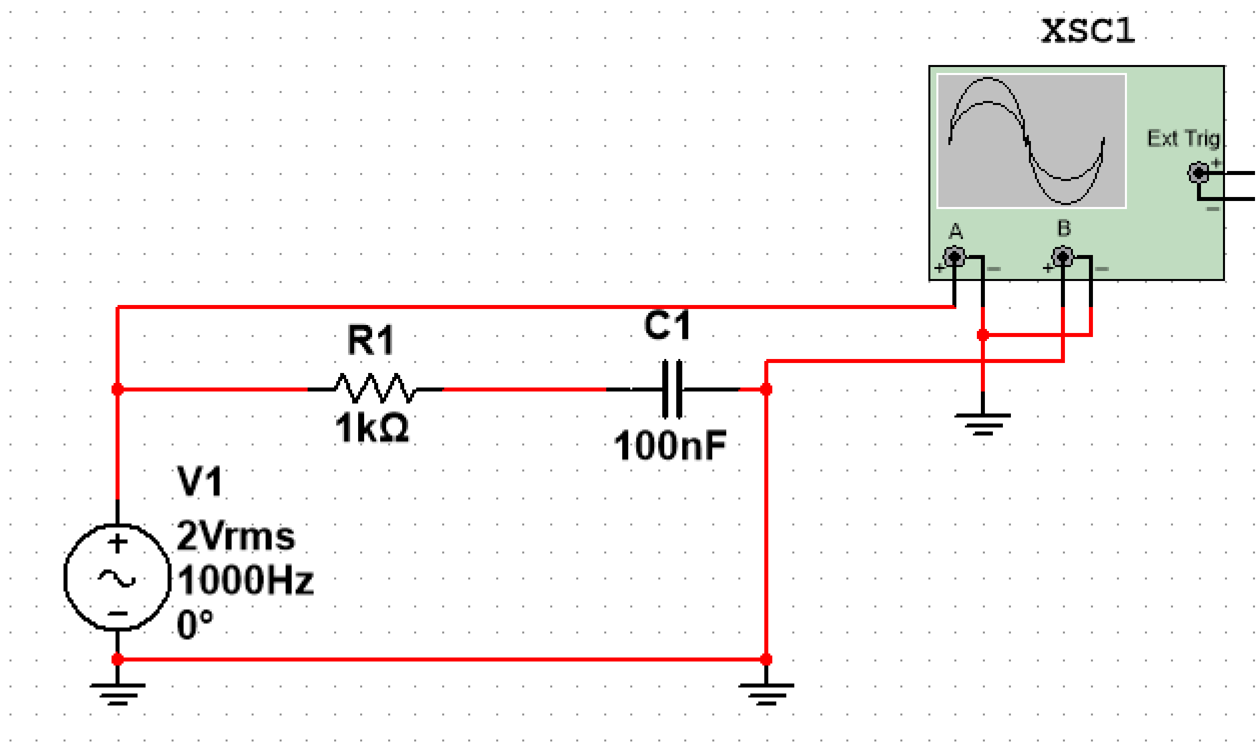
$$T = \frac{1}{f}$$

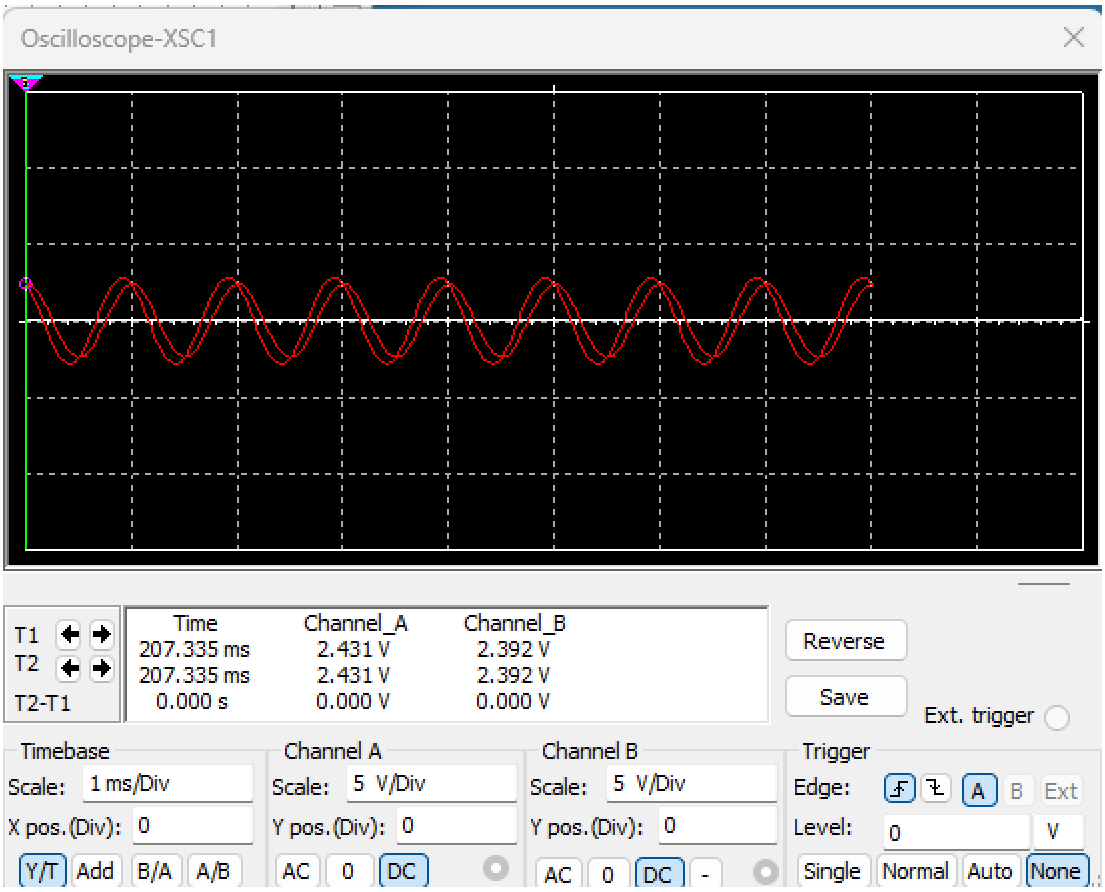
Frequency:

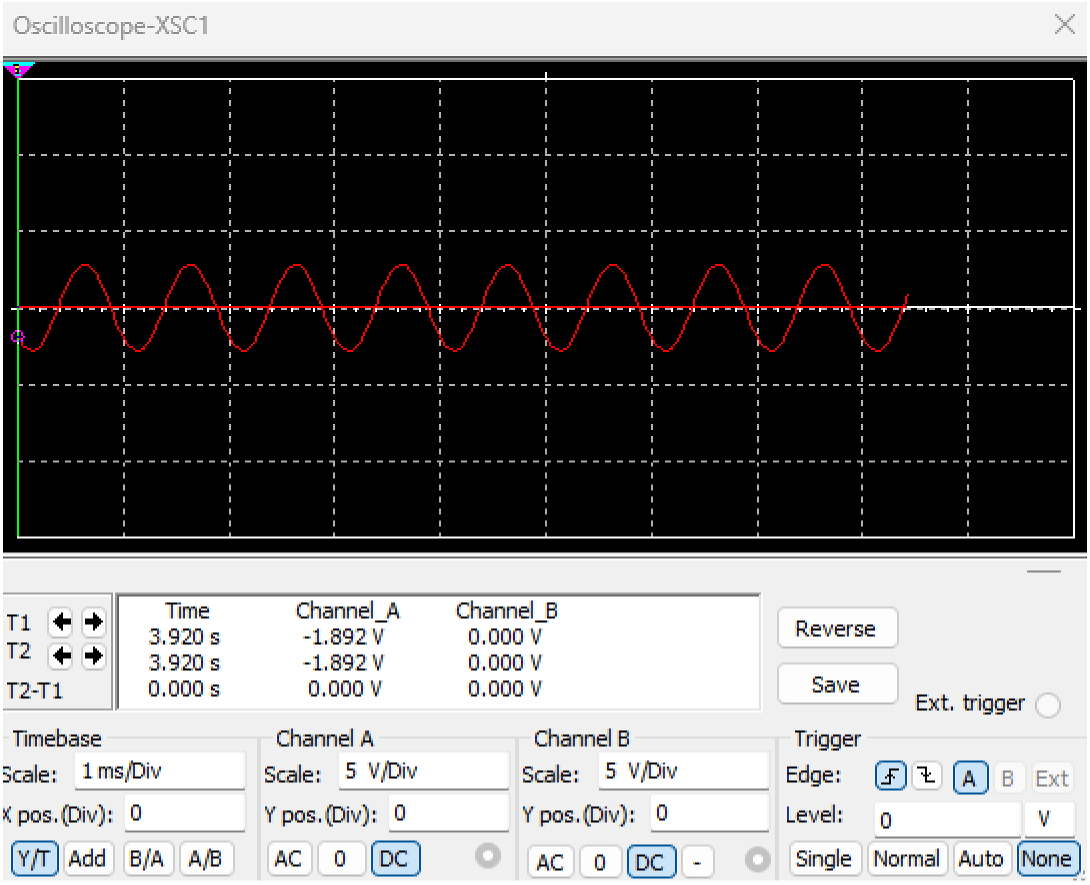
$$f = \frac{1}{T}$$

The input signal can be a sine wave, square wave, or other waveforms, with its frequency set by the signal generator.

Circiut Diagram


XSC1
Ext Trig
A
B
R1
1kΩ
C1
100nF
V1
2Vrms
1000Hz
0°


Oscilloscope-XSC1
Time
Channel_A
Channel_B
T1
207.335 ms
2.431 V
2.392 V
T2
207.335 ms
2.431 V
2.392 V
T2-T1
0.000 s
0.000 V
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 1 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 5 V/Div
Y pos.(Div): 0
AC 0 DC
Channel B
Scale: 5 V/Div
Y pos.(Div): 0
AC 0 DC -
Trigger
Edge: A B Ext
Level: 0 V
Single Normal Auto None



Data Table

$V_S(V)$	$V_R(V)$	$V_C(V)$	τ_R	τ_C	$T(ms)$	$f(Hz)$
2V	1.26V	2V	0.1ms	0.1ms	1ms	1kHz
2V	605mV	2V	0.1ms	0.1ms	0.2ms	5kHz