RC Circuit measurement

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Introduction and Aim

This experiment explores the behaviour of a simple RC (Resistor-Capacitor) circuit and understand its response to changes in input voltage. To achieve this, we will use a linear potentiometer as a variable resistor in the circuit. A potentiometer, oBen referred to as a pot, is a three-terminal resistor with an adjustable tap that allows us to change the resistance value along its length. In this experiment, we will utilize a linear poten@ometer to vary the resistance in the RC circuit. By adjusting the potentiometer, we can control the rate at which the capacitor charges and discharges, thus influencing the time constant and the behaviour of the circuit.

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:

$$V_C(t) = V_c 0 \cdot e^{\frac{-t}{\tau}}$$

Here, $\tau = R \cdot C$ is the time constant, and $v_C 0$ 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:

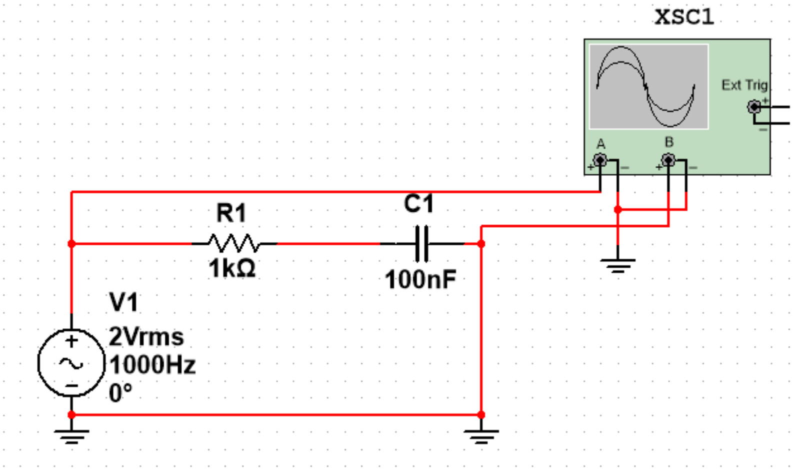
$$T = \frac{1}{f}$$

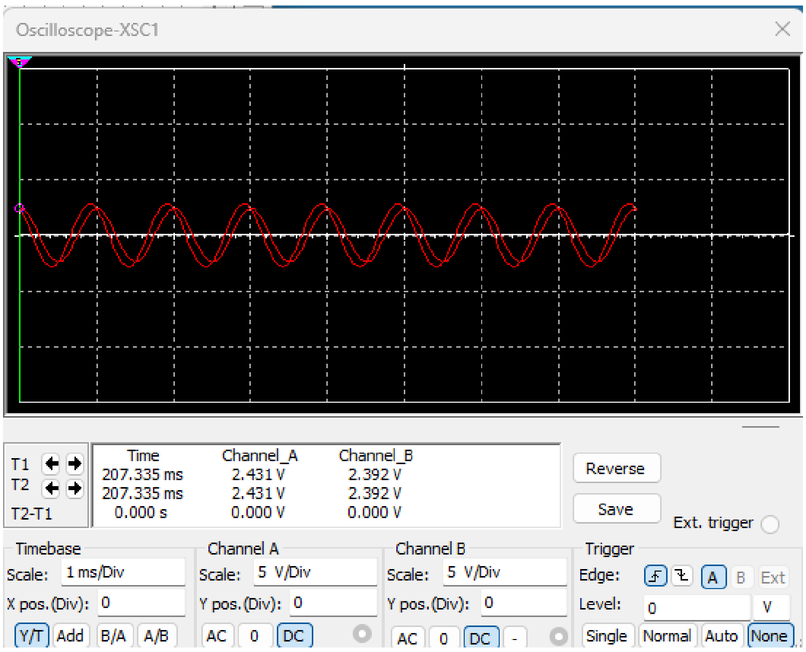
Frequency:

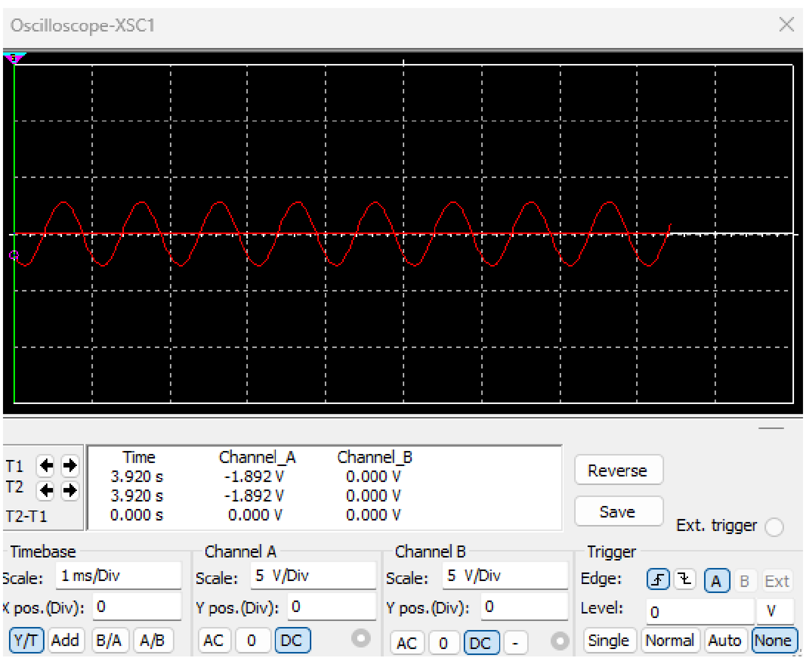
$$f = \frac{1}{T}$$

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

Circiut Diagram







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

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