The Poten1ometer-Capacitor RC Circuit

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1 Introduction and Aim

The aim of this experiment is to investigate the behavior of a simple RC (Resistor-Capacitor) circuit in simulation using NI Multisim, focusing on the relationship between the peak-to-peak voltages across the potentiometer () and the capacitor () under varying frequency and resistance conditions.

2 Theory

The experiment involves studying an RC circuit, which demonstrates how voltage is distributed across resistive and capacitive components when subjected to an AC signal. The impedance of a capacitor () is frequency-dependent and is given by:

where is the frequency of the AC signal and is the capacitance. The voltage across the capacitor and resistor depends on the impedance ratio, influencing the circuit's behavior at different frequencies. The time constant of the circuit is defined as:

This determines how quickly the capacitor charges or discharges. The experiment seeks to analyze how these principles manifest in a simulated setup, measuring the voltages and across varying frequencies and potentiometer settings.

3 Experimental Method and Results

3.1 Circuit Diagram The circuit was constructed in NI Multisim, featuring the following components:

- A potentiometer (variable resistor) with adjustable resistance.
- A capacitor with a capacitance of 47 nF.
- A 5V AC source providing an alternating voltage signal at varying frequencies.
- Voltage probes to measure peak-to-peak voltages across the potentiometer and capacitor.

The circuit diagram is shown below:

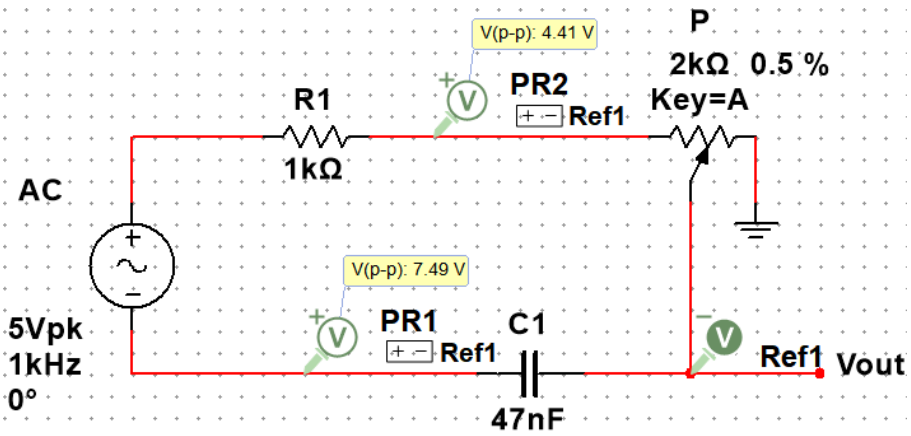

Figure 1: Circuit Diagram

3.2 Experimental Method The experiment was performed as follows:

- The circuit was set up in NI Multisim, and an AC voltage source provided a 5V signal at a frequency of 1 kHz.
- Voltage probes were connected to the potentiometer and capacitor to measure peak-to-peak voltages.
- The potentiometer was adjusted incrementally from 0.5
- The procedure was repeated for frequencies of 2 kHz, 5 kHz, 10 kHz, 20 kHz, 50 kHz, and 100 kHz.
- Data was collected by running the simulation in Interactive Mode.

3.3 Results and Discussion The results were plotted as graphs of versus for each frequency, revealing the following:

- **At Low Frequencies (1 kHz, 2 kHz):** The capacitor dominates the voltage distribution due to its higher impedance, resulting in higher and lower .
- **At High Frequencies (50 kHz, 100 kHz):** The capacitor's impedance decreases, leading to lower and higher .
- **Potentiometer Position Effect:** Resistance adjustments influenced the charging and discharging rates of the capacitor, altering the voltage distribution.

Sample frequency response graphs are shown below:

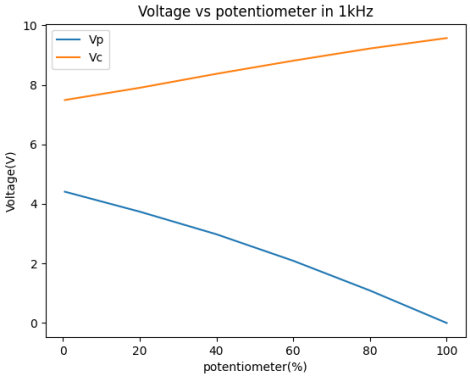

Figure 2: 1kHz AC Signal Frequency

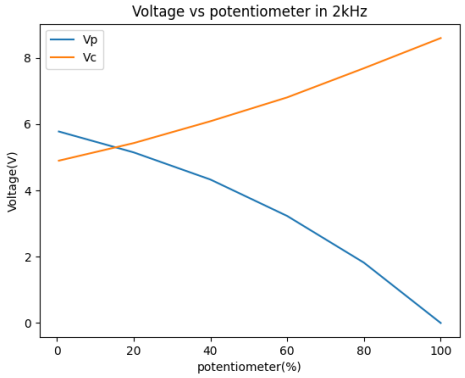

Figure 3: 2kHz AC Signal Frequency

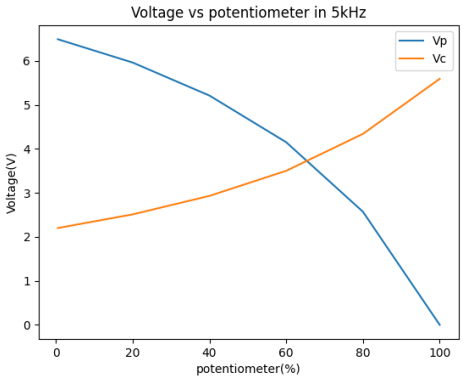

Figure 4: 5kHz AC Signal Frequency

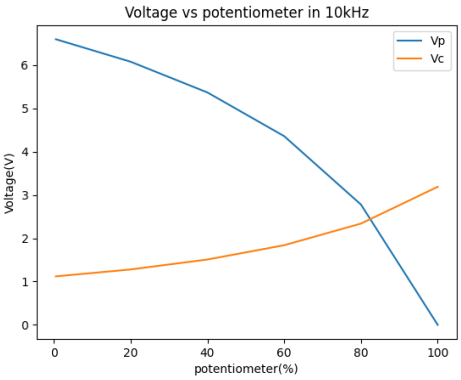

Figure 5: 5kHz AC Signal Frequency

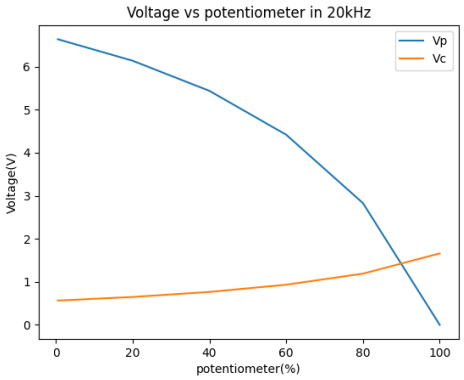

Figure 6: 5kHz AC Signal Frequency

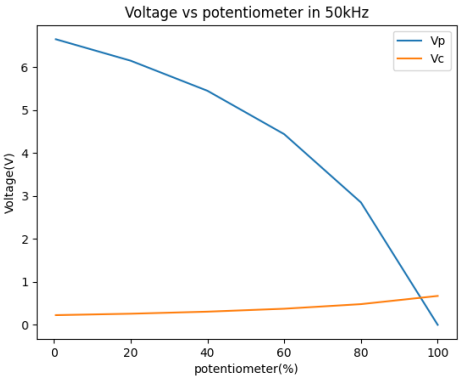

Figure 7: 5kHz AC Signal Frequency

The experimental results align with theoretical predictions, confirming the relationship between impedance, frequency, and voltage distribution in an RC circuit.

4 Conclusion

The simulation demonstrated the frequency-dependent behavior of an RC circuit, showing how the potentiometer setting and signal frequency affect voltage distribution across the components. The findings support theoretical principles, highlighting the inverse relationship between and at varying frequencies. Future experiments could include phase-shift measurements, filter design, and analyzing the effect of different capacitor values. Using NI Multisim proved effective for visualizing and analyzing circuit dynamics in real time.