Lab Report 1: Introduction to DSO, Breadboard and RC Circuit Experiment

V.L.S. Bhargav ; Lanka Kushwanth
Table Number: 3
Room Number: 114
Roll Number: 2025102061

26-09-2025

Aim:

The aim is to study the Digital Storage Oscilloscope (DSO), understand how a breadboard works, and analyze the charging and discharging behavior of an RC circuit by comparing the theoretical and practical values of the time constant and cutoff frequency.

Components Used:

1. Breadboard
2. Resistors (various values)
3. Capacitors (ceramic and polarized, various values)
4. Digital Storage Oscilloscope (DSO)
5. Function Generator

Procedure:

1. Connect the RC circuit on the breadboard as shown in the lab handout.
2. Use the function generator to apply a square wave input.
3. Observe the waveform of the capacitor on the DSO screen.
4. For each R and C combination:
   - 4.1. Calculate the theoretical time constant ($\tau = RC$).
   - 4.2. Measure the practical time constant from the DSO waveform.
   - 4.3. Calculate the theoretical cut-off frequency ($f_c = \frac{1}{2\pi RC}$).
   - 4.4. Measure the practical cutoff frequency using the DSO.
   - 4.5. Record all the values in the observation table.
5. Repeat steps 4 and 5 for three different combinations of R-C.

Circuit Diagram:

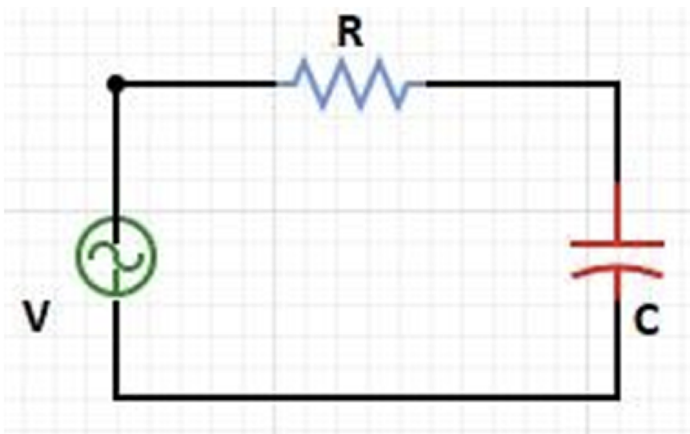
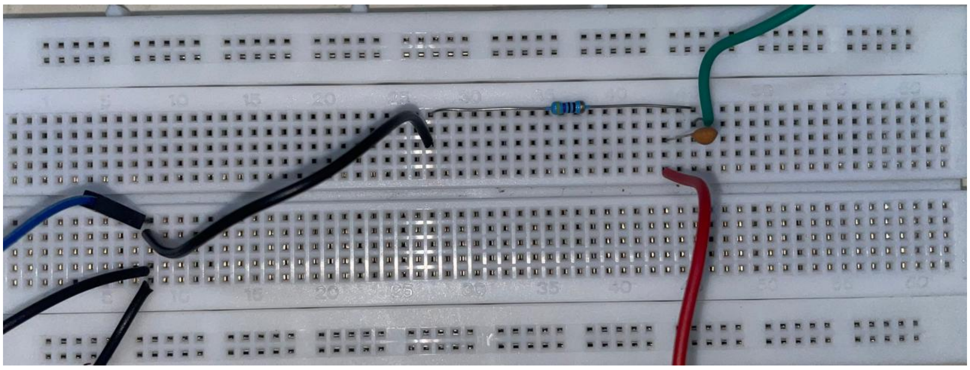
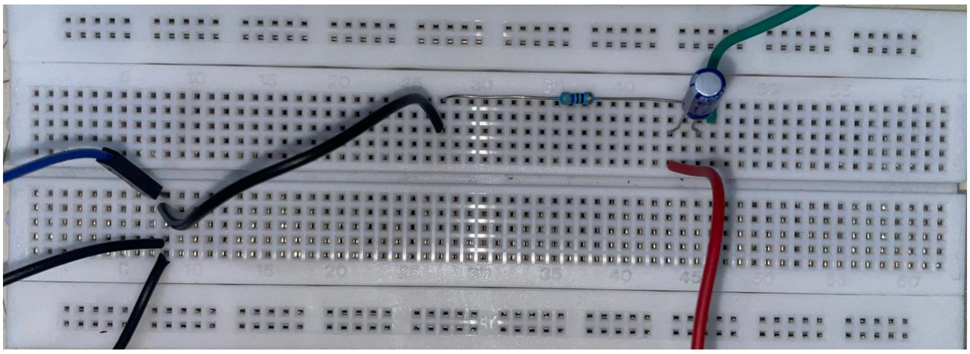


Figure 1: Physical RC circuit implemented on PCB.

Physical Circuit:



(a) Ceramic capacitor used in Case 1.

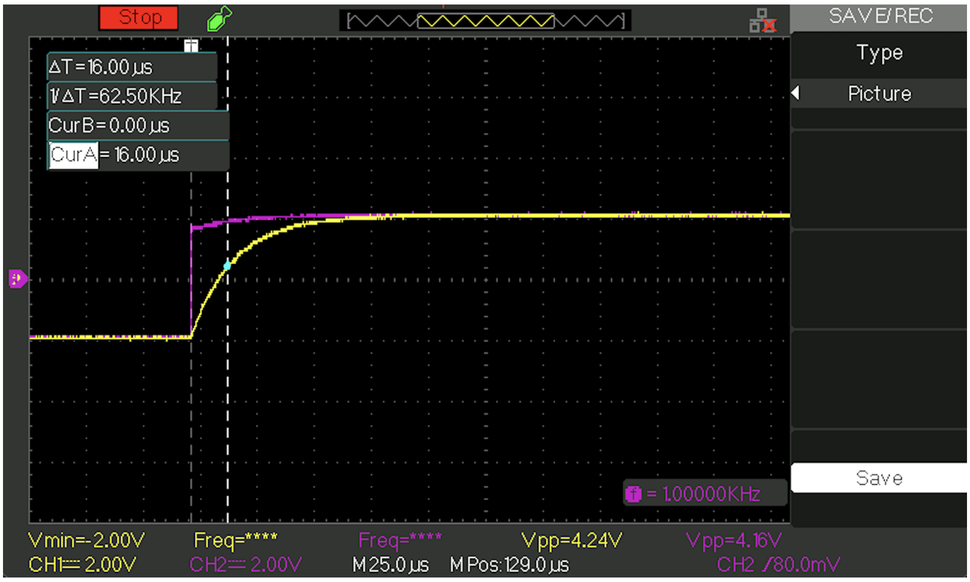


(b) Polarized capacitor used in Case 2.

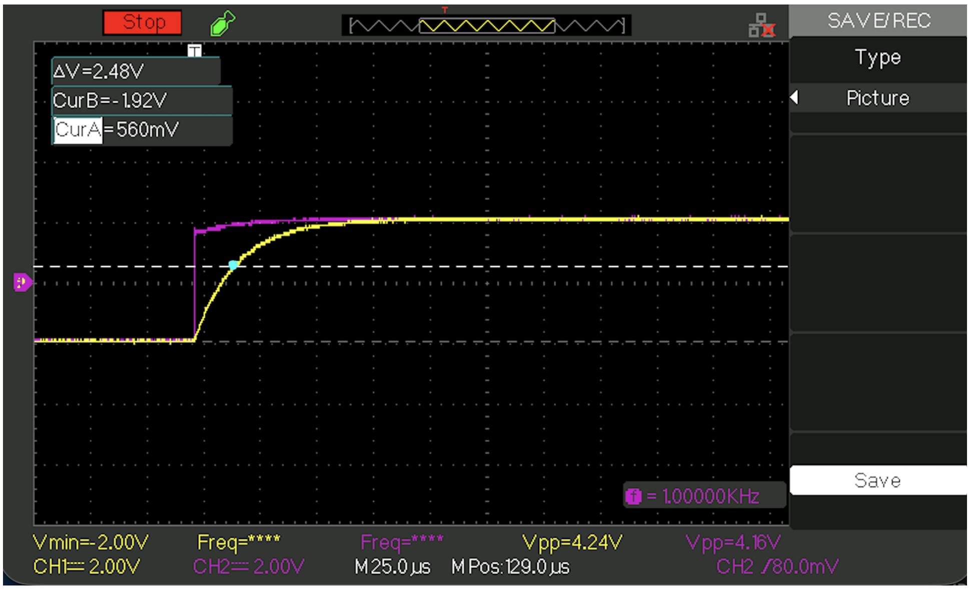
Figure 2: Types of capacitors used in the RC circuit.

Observation:

Experimental Waveforms:

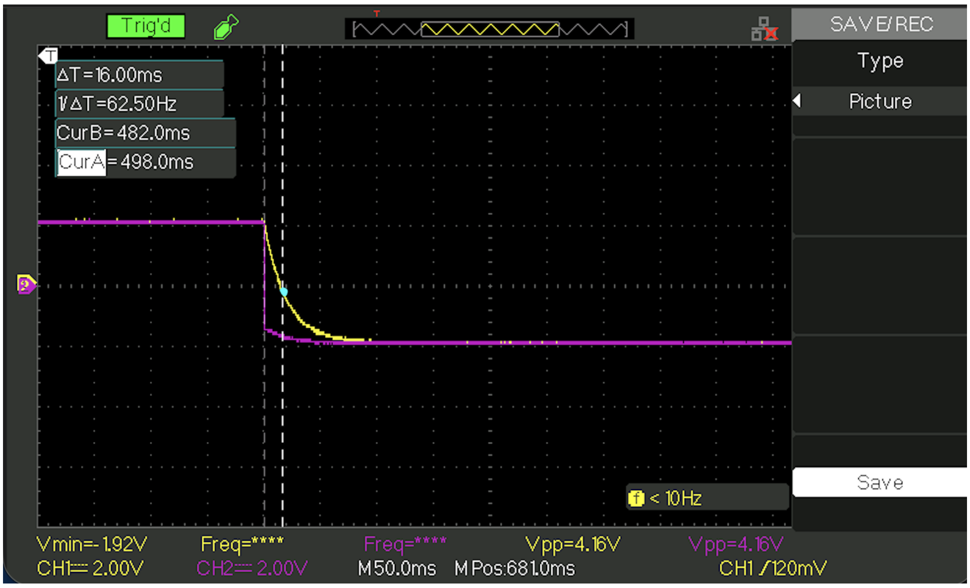


(a) Time response for Case 1 (Δt)

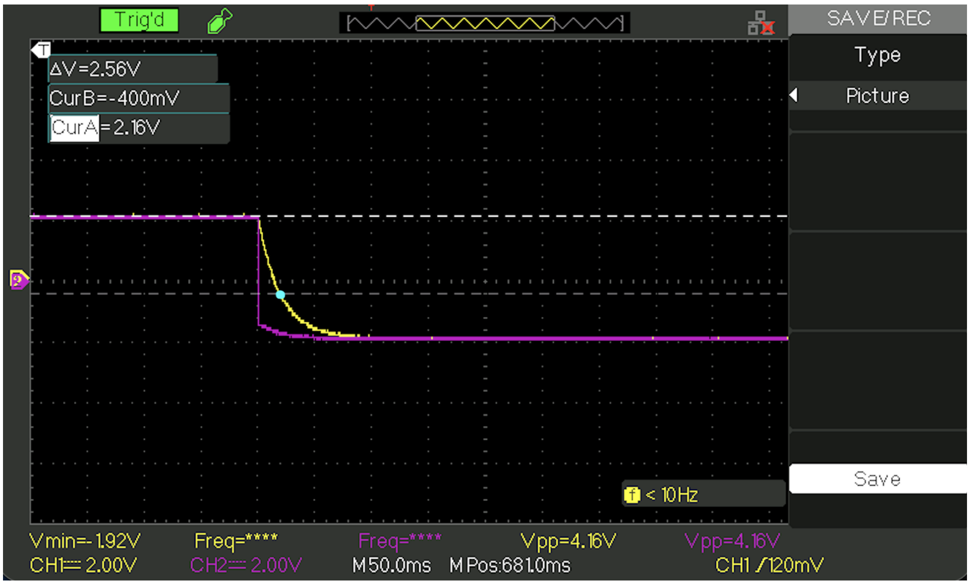


(b) Voltage response for Case 1 (ΔV)

Figure 3: Experimental waveforms of the RC circuit for Case 1.



(a) Time response for Case 2 (Δt)

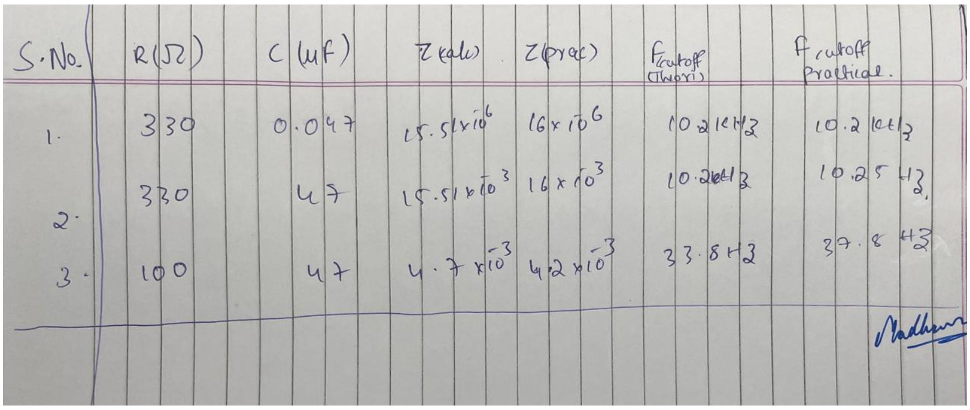


(b) Voltage response for Case 2 (ΔV)

Figure 4: Experimental waveforms of the RC circuit for Case 2.

Observation Table:

Theoretical and practical values of the time constant and cutoff frequency were measured for different combinations of resistors and capacitors. The results are tabulated below:



S.No.	R(Ω)	C (μF)	τ (calc)	τ (prac)	f cutoff (Theory)	f cutoff Practical.
1.	330	0.047	15.51×10^{-6}	16×10^{-6}	10.2 kHz	10.2 kHz
2.	330	47	15.51×10^{-3}	16×10^{-3}	10.2 Hz	10.25 Hz
3.	100	47	4.7×10^{-3}	4.2×10^{-3}	33.8 Hz	37.8 Hz

Figure 5: Observation table of RC circuit on PCB.

Explanation:

The behavior of an RC circuit can be understood using its time constant, cutoff frequency, and transfer function.

Time Constant:

The time constant τ is defined as:

$$\boxed{\tau = R \times C} \tag{1}$$

During charging, the capacitor voltage is:

$$\boxed{V_c(t) = V_{in}\left(1 - e^{-t/\tau}\right)} \tag{2}$$

which shows that the capacitor charges up to about 63.2% of the input voltage in one time constant.
During discharging, the capacitor voltage is:

$$\boxed{V_c(t) = V_{in} e^{-t/\tau}} \tag{3}$$

which means that about 36.8% of the initial voltage remains after one time constant.

Cutoff Frequency:

The cutoff frequency f_c of the RC circuit is:

$$\boxed{f_c = \frac{1}{2\pi RC}} \tag{4}$$

At this frequency, the output amplitude is reduced to about $\frac{1}{\sqrt{2}}$ (approximately 70%) of the input, which corresponds to a reduction of 3 dB.

Conclusion:

- Gained an understanding of the functioning and basic controls of the Digital Storage Oscilloscope (DSO).
- Learned the structure and application of the breadboard for making circuit connections.
- Analyzed the charging and discharging behavior of RC circuits.
- Compared theoretical and practical values of the time constant (τ) and cutoff frequency (f_c).
- Minor deviations between theoretical and experimental results were observed due to:
  - Resistor and capacitor tolerances
  - Parasitic effects in the setup
  - Measurement limitations

References:

- Lab manual: Introduction to DSO, Breadboard and RC Circuit Experiment
- Engineering Circuit Analysis by William Hayt et al.
- Signals and Systems by V.A. Oppenheim et al.

Lab Report 2: RC Circuit on PCB and Introduction to Soldering

V.L.S. Bhargav ; Lanka Kushwanth
Table Number: 3
Room Number: 114
Roll Number: 2025102061

30-09-2025

Aim:

The aim of this experiment is to learn the soldering process and build an RC circuit on a PCB. The objective is to study its time constant, observe the frequency response, and compare the theoretical results with the practical ones.

Components Used:

1. Resistors (different values)
2. Capacitors (different values, including electrolytic)
3. Breadboard and PCB
4. Function generator
5. Oscilloscope (DSO)
6. Multimeter
7. Soldering iron, stand, solder, solder sucker, solder wick
8. Connecting wires

Procedure:

1. Heat up the soldering iron and clean the tip with a damp sponge.
2. Tin the tip with solder to improve conductivity and heat transfer.
3. Place the RC circuit components onto the PCB as per the circuit diagram.
4. Secure the components by bending their leads and solder them carefully, starting with the smaller ones.
5. Check the solder joints to ensure they are shiny, solid, and free from solder bridges.
6. Trim extra leads and clean the board using solder wick or solder sucker if needed.
7. Verify circuit continuity with a multimeter.
8. Connect the circuit to a function generator and observe the capacitor's response using a DSO.
9. Change the input frequency and record the practical time constant and cutoff frequency.
10. Compare the PCB results with those from the breadboard implementation.

Circuit Diagram:

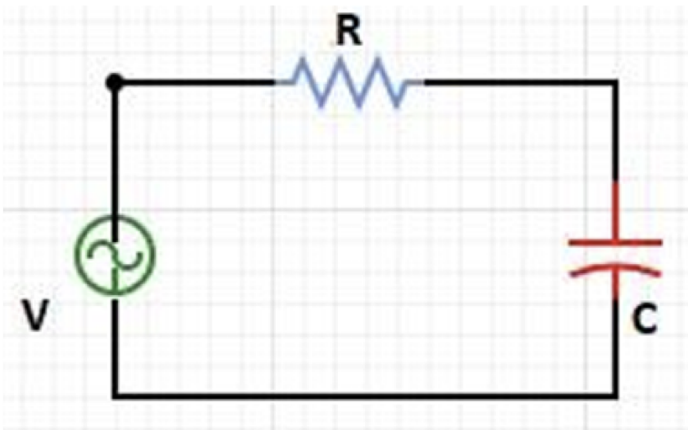


Figure 1: Schematic of the RC circuit implemented on PCB.

Physical Circuit:

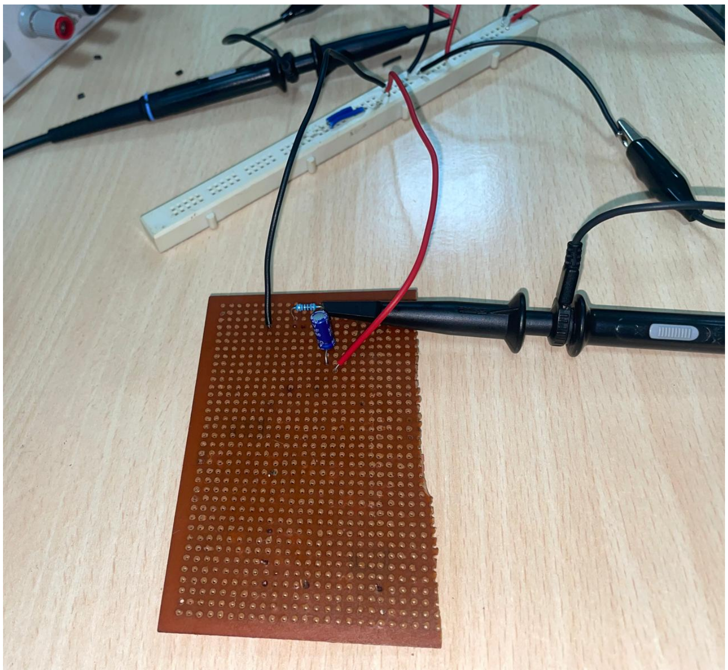


Figure 2: Physical RC circuit implemented on PCB.

Observation:

Experimental Waveforms and Table:

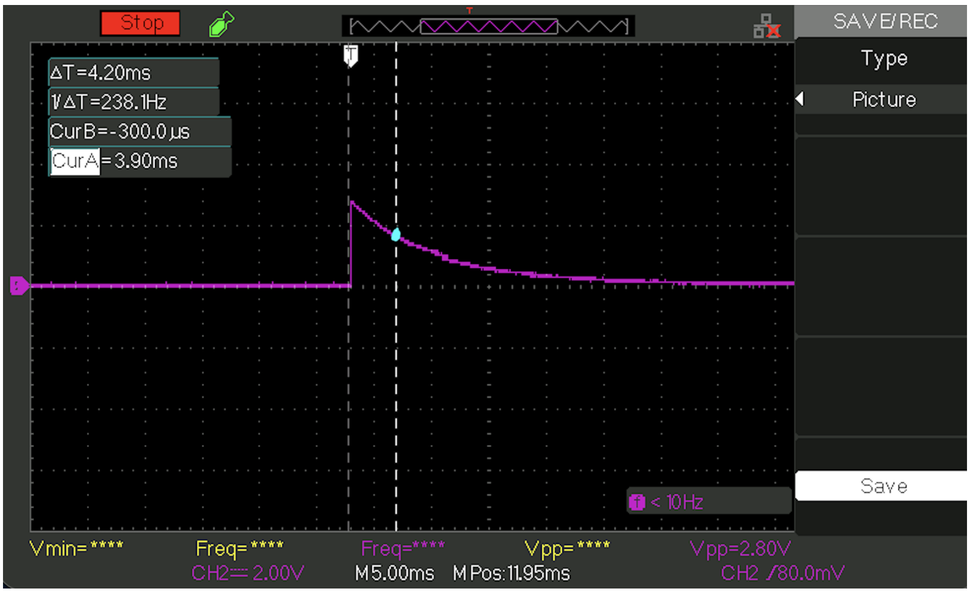


Figure 3: Time response (Δt) of RC circuit on PCB.

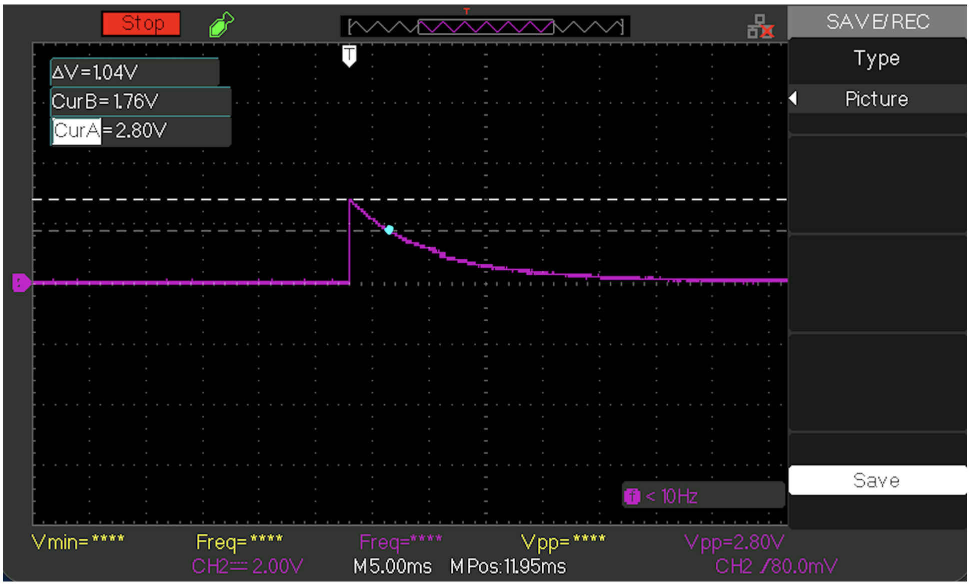
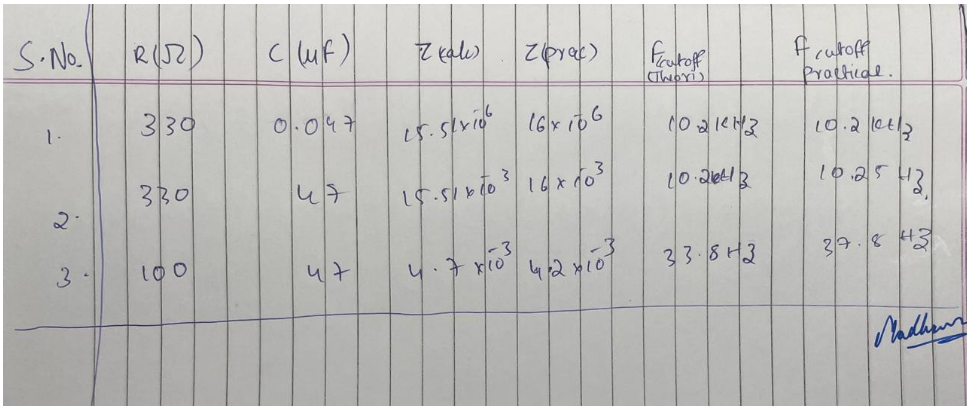


Figure 4: Voltage response (ΔV) of RC circuit on PCB.

Observation Table:

Theoretical and practical values of the time constant and cutoff frequency were measured for different combinations of resistors and capacitors. The results are tabulated below:



S.No.	R(Ω)	C(μF)	τ (calc)	τ (prac)	f_{cutoff} (Theory)	f_{cutoff} Practical
1.	330	0.047	15.51×10^{-6}	16×10^{6}	10.2 kHz	10.2 kHz
2.	330	47	15.51×10^{-3}	16×10^{-3}	10.2 Hz	10.25 Hz
3.	100	47	4.7×10^{-3}	4.2×10^{-3}	33.8 Hz	37.8 Hz

Figure 5: Observation table of RC circuit on PCB.

Explanation:

- Similar to Lab-1, the circuit was assembled using the same components.
- In this lab, the components were soldered onto a PCB (Printed Circuit Board).
- Soldering provides strong and permanent connections between components.
- Using a PCB minimizes loose connections and wiring errors.
- It ensures better stability, durability, and reliability compared to a breadboard.
- The circuit layout becomes more compact and organized, closely resembling practical real-world implementations.

Conclusion:

The experiment introduced soldering and circuit implementation on a PCB. The RC circuit displayed the expected low-pass filter behavior, and the theoretical and practical results were consistent, confirming the concepts of time constant and cutoff frequency.

References:

- Lab manual: Introduction to DSO, Breadboard and RC Circuit Experiment
- Engineering Circuit Analysis by William Hayt et al.
- Signals and Systems by V.A. Oppenheim et al.