Lab5 Report

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PART One:

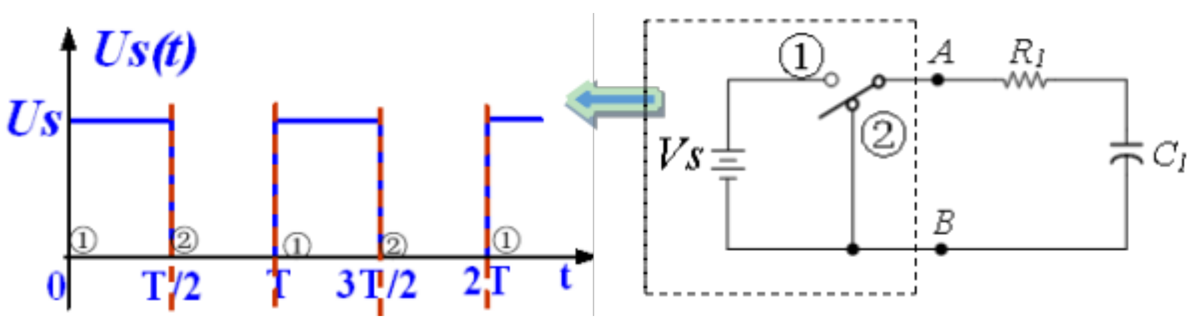
Measure the value of resistors and capacitors using a Digital Multimeter. __/4pt

Table 1: Measured Values

	Nominal Value	Measured Value
R1	2kΩ	1.990 kΩ
R2	3.3kΩ	3.296 kΩ
C1	0.1uF	100.8nF (0.1008 μF)
C2	0.32uF	319.7nF (0.3197 μF)

PART One: Transient Response of RC circuit @ square wave, R=2kΩ, C=0. 1uF

As shown in Fig.1 (Fig. 1 in Prelab5), the components in the dotted box are analogous to a square-wave generator, which can be produced by a function generator. Please note that in order to observe the complete process of charging and discharging of the Capacitor, the period T of the square wave must be long enough



to allow the complete. Usually T >10τ is appropriate for this purpose.

Figure1. First order RC circuit

1. Construct the circuit given in figure1 on the bread board, as shown in Fig.2, the resistor R=2kΩ, C=0. 1uF.

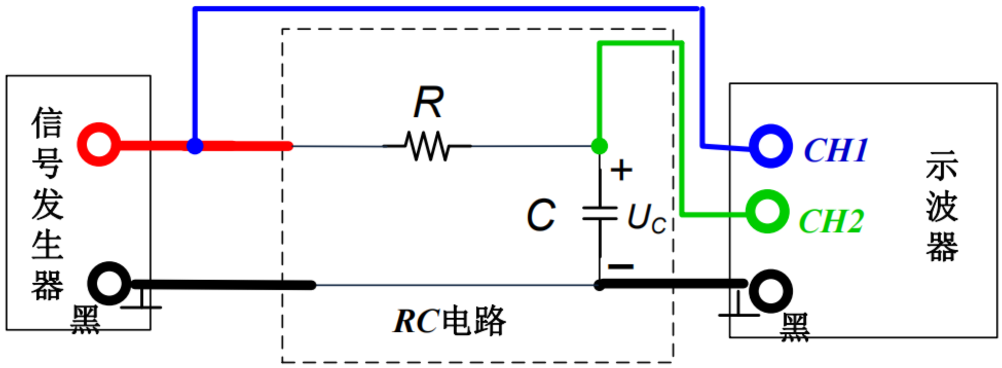


Fig.2

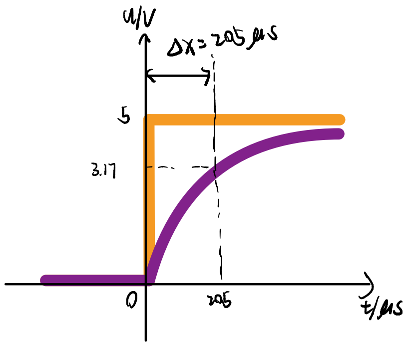
2. Short the capacitor firstly to ensure the capacitor is fully discharged every time you do the RC experiment by a connection wire. Make sure that the capacitor is connected so that its (+) terminal is at higher potential than its (−) terminal.
3. A 0-5V, 150 Hz, 50% duty cycle square wave is generated by the Signal Generator to provide an "off" (0 V) and an "on", which makes the capacitor to charge and discharge.
4. Simultaneously monitor Vin and Vout of the circuit using the oscilloscope: Connect the Channel 1 probe of the oscilloscope to the output of the signal generator to verify the square wave is what we want, and Channel 2 probe to the voltage across the capacitor.
5. Now record the time (t) it takes for the voltage of the capacitor to reach 63% of the highest voltage.

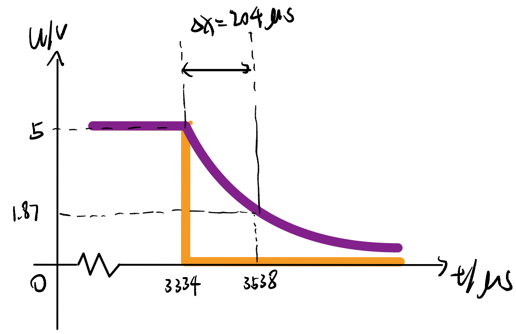
Similarly, record the time when the discharging voltage decreases 63% from its highest voltage. Find the average of these two values and use this as the experimental time constant. __/6pt

$\tau = 205\mu s$

$\tau = 204\ \mu s$ average: $\frac{1}{2}(205+204) = 204.5\mu s$

6. Plot the oscilloscope trace and include it in your laboratory report. Illustrate in your sketch how you obtained the time constant and the values you used. __/8pt





I obtain the time constant by adjusting the cursor to the position where the y coordinate value is about 3.15V (5V×63%) in the charging process while 1.85V (5V×(1-63%)) in the discharging process, then observing the difference between the x-coordinate and the inital position.

The values I use are the y coordinate value (by observing it) and Δx.

7. Compare your measured value with the product of RC obtained from the individual values of R and C measured earlier and equation τ = RC. __/3pt

experimental. 204.5 μs

error $\left|\frac{204.5-200.592}{200.592}\right| \times 100\% = 1.95\%$

mearsured: $\tau = RC = 1990 \times 0.1008 = 200.592\ \mu s$

The result shows that the experimental value is close to the measured one calculated by $\tau = RC$

PART TWO:

Transient Response of RC circuit @ square wave, R=3.3 kΩ||2kΩ, C=0. 1uF

For the first-order RC circuit considered in Fig.1 (Fig. 1 in Prelab5), introduce a second resistor R2 3.3kΩ in parallel with R1=2kΩ, C=0.1μF,.

1. Record the time (t) it takes for the voltage of the capacitor to reach 63% of the highest voltage. Similarly, record the time when the discharging voltage decreases 63% from its highest voltage. Find the average of these two values and use this as the experimental time constant. __/6pt

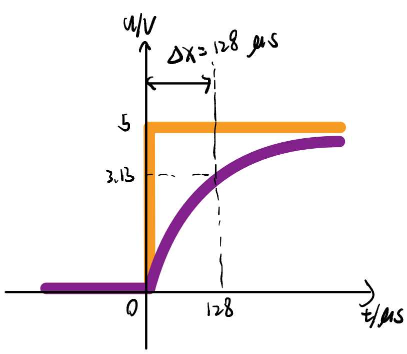
128 μs

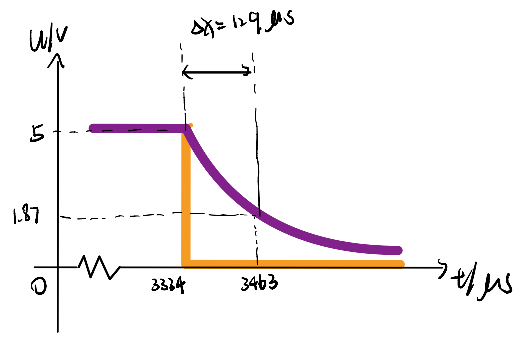
129 μs

average

$\frac{1}{2}(128+129) = 128.5\,\mu s$

2. Plot the oscilloscope trace and include it in your laboratory report. Illustrate in your sketch how you obtained the time constant and the values you used. __/8pt





I obtain the time constant by adjusting the cursor to the position where the y coordinate value is about 3.15 V (5V × 63%) in the charging process while 1.85V (5V×(1−63%)) in the discharging process, then observing the difference between the x-coordinate and the inital position.
The values I use are the y coordinate value (by observing it) and Δx.

3. Compare your measured value with the product of RC obtained from the individual values of R and C measured earlier and equation τ = RC. __/3pt

experimental: 128.5 μs

error $\left|\frac{128.5 - 125.08}{125.08}\right| \times 100\% = 2.73\%$

mearsured: $\tau = RC \approx 125.08\,\mu s$

The result shows that the experimental value is close to the measured one caculated by $\tau = RC$

PART THREE:

Transient Response of RC circuit @ square wave, R=2kΩ, C=0. 32uF(0.22 uF||0.1 uF)

For the first-order RC circuit considered in Fig.1 (Fig. 1 in Prelab5), introduce a second capacitor C2 0.22μF in parallel with C1=0.1μF, that is C1=0.32μF, R1=2kΩ.

1. Record the time (t) it takes for the voltage of the capacitor to reach 63% of the highest voltage. Similarly, record the time when the discharging voltage decreases 63% from its highest voltage. Find the average of these two values and use this as the experimental time constant. __/6pt

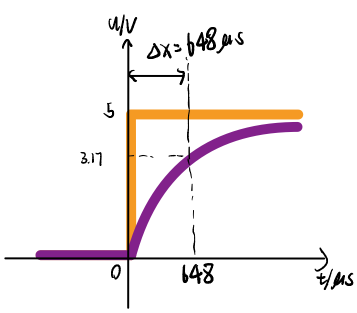
$t=648\mu s$

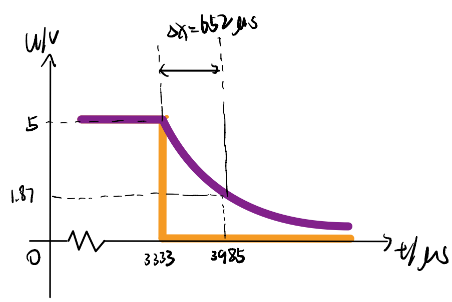
$652\mu s$

average

$\frac{1}{2}(648+652)=650\mu s$

2. Plot the oscilloscope trace and include it in your laboratory report. Illustrate in your sketch how you obtained the time constant and the values you used. __/8pt





I obtain the time constant by adjusting the cursor to the position where the y coordinate value is about 3.15V (5V×63%) in the charging process while 1.85V (5V×(1-63%)) in the discharging process, then observing the difference between the x-coordinate and the inital position.

The values I use are the y coordinate value (by observing it) and Δx.

3. Compare your measured value with the product of RC obtained from the individual values of R and C measured earlier and equation τ = RC. __/3pt

experimental. 650 μs

error $\left|\frac{650-636.2}{636.2}\right| \times 100\% = 2.17\%$

mearsured: $\tau = RC = 1990 \times 0.3197 = 636.2$ μs

The result shows that the experimental value is close to the measured one caculated by $\tau = RC$

PART FOUR: Conclusion

Based on the data you recorded in the above steps, analyze the effects of the circuit parameters to first-order RC circuits. __/8pt

Unlike the resistors which dissipate energy, capacitors is an important passive linear circuit element which don't dissipate but store energy. The RC circuit is a first order circuit with a resistor and a capacitor in series connected to a voltage source. Based on the data and the formula $\tau = RC$, we can find that by increasing the value of R and C can both increase time constant, and we can also find that the natural response of an RC circuit is an exponential decay of the initial voltage. The time constant determined by R and C governs the rate of decay.

Finally, before leaving lab, turn off all equipment and return cables to their proper place. Leave your lab station clean and ready for other students to use. Thank you!

TA check off: