Li Mingwei 522370910036

UM-SJTU JI VE215 Lab #4

In this lab, we will evaluate some characteristics of first order RC circuit.

- Please hand in your post-lab assignment before the due date. Please do your post-lab assignment following the requirements in each problem. Both hand-written and printed are accepted.
- You are encouraged to print this lab manual and then finish the post-lab questions on it. For pictures or diagrams, you may print it in a paper, cut it down and paste on this worksheet.
- **Always attach the pictures or screenshots of your waveforms if using the oscilloscope.**

Instruments

Function Generator with coaxial cables

Oscilloscope with coaxial cables

Multi-meter

Breadboard and Wires

Capacitors of $\mathbf{0.1\mu F}$

Resistors of $\mathbf{1k\Omega}$

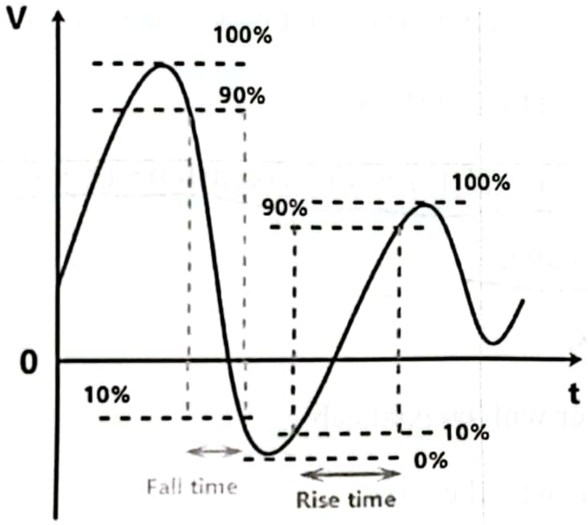
Rheostat $\mathbf{0\Omega \sim 10k\Omega}$

Problem #1 Rise time and fall time(self learning)

New concepts of "rise time" and "fall time" are introduced to evaluate some characteristics of signals. In the oscilloscope, we may choose the "Rise Time" or "Fall Time" function to measure them directly.

The **rise time** of a signal is defined as the time interval between the moment when an increasing signal reaches its 10% and the moment when it first reaches its 90% level.

The **fall time** of a signal is defined as the time interval between the moment when a falling signal reaches its 90% and the moment when it first reaches its 10% level.



Post-Lab Questions for (P1)

(1) Please calculate the rise time or fall time of a first-order circuit whose time constant is equal to **τ**.

take ~~it as of~~ the ~~function of~~ voltage as an example.

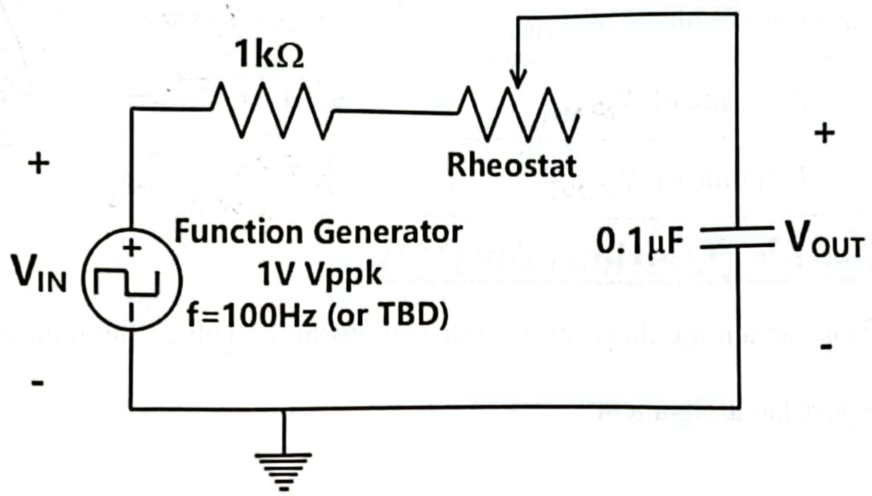
$u = u_0 e^{-\frac{t}{\tau}}$, ~~$u = 0.9u_0$~~ $t = \tau \ln(\frac{u_0}{u})$

$|t_{09} - t_{01}| = \tau \ln(\frac{0.9u_0}{0.1u_0}) = \tau \ln 9 \approx 2.197\tau$

Problem #2 First Order (RC) Circuit

Firstly, please adjust your Rheostat and then measure its resistance using multi-meter. Please fill its resistance in the following table..

Resistance of Rheostat	6.539kΩ



Then, please connect the circuit based on the Schematic above, turn on the function generator and then set a <u>square wave</u> at **1 Vppk** and **100 Hz.**

<u>**Caution: Please set the output impedance of function generator to high-Z mode.**</u> Besides, <u>please use the oscilloscope to measure the voltages by monitoring the input signal in Channel 1 and the output in Channel 2</u>.

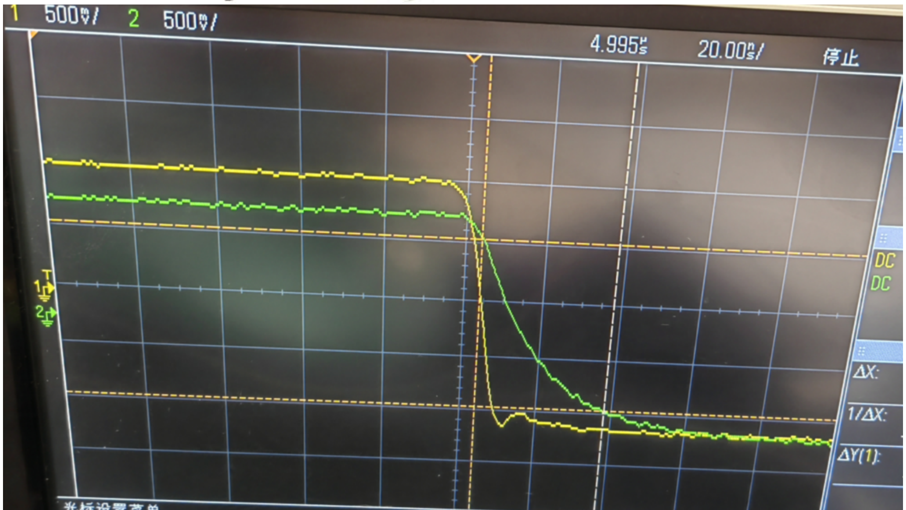
You may adjust the frequency of function generator in order to let the capacitor can be fully charged or discharged during the half period of the input wave if necessary. After that, please measure the <u>Peak-to-peak voltage of the Input square wave</u> V_{IN}, <u>Peak-to-peak voltage of the Output</u>

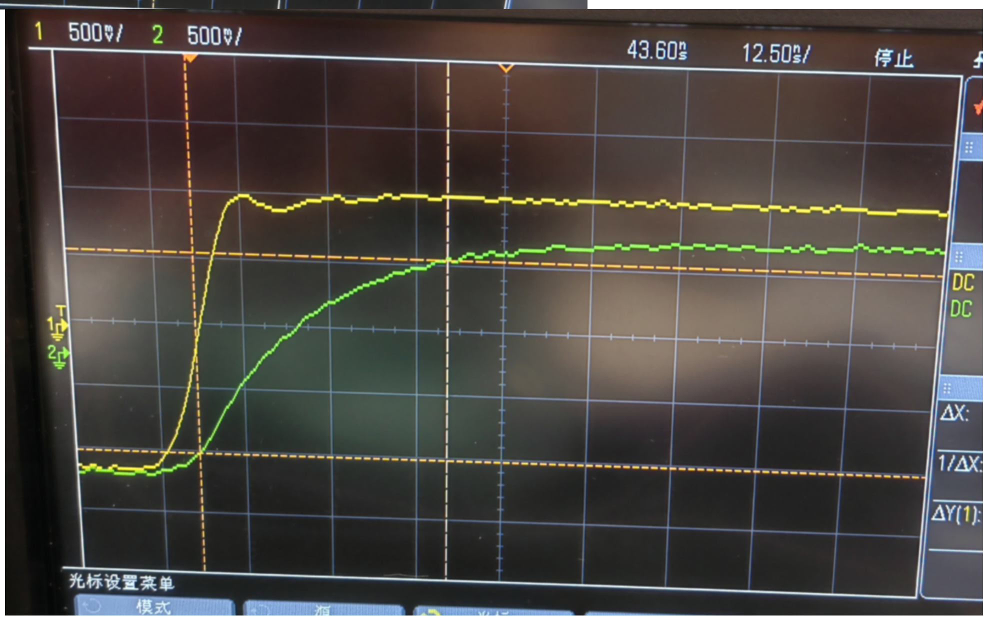
square wave V_{OUT}, The rise time and fall time of the Input square wave V_{IN}. Please screenshot or take photos of your waveform and complete the following table during your measurement.

Terms	Values
Peak-to-peak voltage of V_{IN}	1.03250V ~~2.74375V~~ 1.09500V
Peak-to-peak voltage of V_{OUT}	992.50mV ~~1.88750V~~ 0.97000V
Rise time of $V_{\cancel{IN}}$ OUT	~~3.64×10^-8 s~~ 1.64ms
Fall time of $V_{\cancel{IN}}$ OUT	~~3.50×~~ 3.38×10^-8 s 1.72ms

Post-Lab Questions for (P2)

(1) Please attach the diagram of your waveform as well as the data table in the post-lab assignment.





(2) What are the theoretical values of the rise time and fall time of the circuit according to the rheostat resistance you choose? Please compare them with the experimental results and list some possible reasons if they are not the same.

$t_{theo} = 2.197RC = 2.197 \times (6539 \overset{+1}{\cancel{\times}}) 10^3 \times 0.1 \times 10^{-6} = \overset{1.6}{\cancel{1}}56\ ms$

~~They are~~ It's almost the same as the experimental values

The minor difference may result from the noise in the source and DC components

(3) What's the minimum period of the input signal in order to let the capacitor can be fully charged or discharged according to the rheostat resistance you choose?

$T_{theo} = 2 \times 1.656ms = 3.312ms$

$T_{exp} = 1.64ms + 1.72ms = 3.36ms.$

Post-Lab Reflection Questions

(1) Is your experimental result the same as your analysis (Need data as proof)? If not, how do you interpret this difference? What do you think is the source of the experimental error?

(2) What do you learn from this experiment? (e.g. what experimental procedures, how to debug, etc.)

(1) Yes. ~~the exp $t_{ex} = 1.656ms$. t_{theo}~~

$t_{ef} = 1.64ms$ $t_{er} = 1.72ms$, $t_{th} = 1.656ms$. $\varepsilon_f = 1.0\%$ $\varepsilon_r = 3.9\%$ The difference is not so large.

The AC may include some DC components, and the noise matters.