Lab 1 RC Circuit

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EE233 Circuit Theory

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***Abstract*—**

I. Introduction

II. Lab Procedure

III. Experimental Procedure and Analysis

A. The RC Response to a DC Input

1) Square Wave Input Analysis:

We built the circuit in figure 1 with a resistor of $10\text{k}\Omega$ and a capacitor of $0.01\mu\text{F}$. We set the function generator to provide a square wave input with the period $T = 4.00000000\text{ms}$ and the voltage of $V_{pp} = 5\text{V}$ with offset $+2.5\text{V}$, which generates a square wave of maximum voltage 5V and minimum 0V.

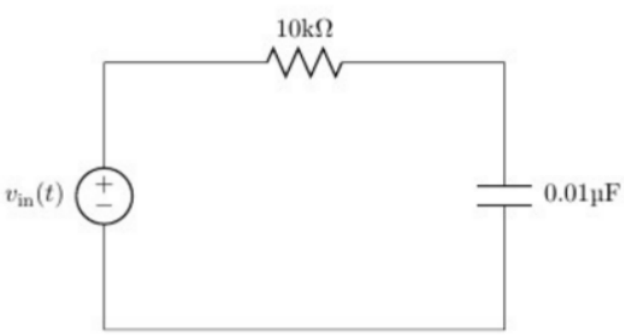

Fig. 1. RC circuit for square wave input analysis

We used channel 1 of the oscilloscope to verify the input and measured the output voltage of the capacitor by channel 2. Figure 2 is the screen output of two and half cycles.

Analyze #1:

The oscilloscope did display the same waveform plotted in Prelab#7. They are of the same shape, and both of their peaks and valleys reach the input waveform. Meanwhile, no obvious difference is found.

Using the *Cursor* menu, we recorded the period T, as well as the range of the output signal. Then we measured the time value of the 10%, 90%, and 50% point of V_{out}. The results are shown in table I.

Analysis #2:

After calculating the rise time, fall time, and delay time of the RC circuit, we got table II

2) Time Constant Measurement:

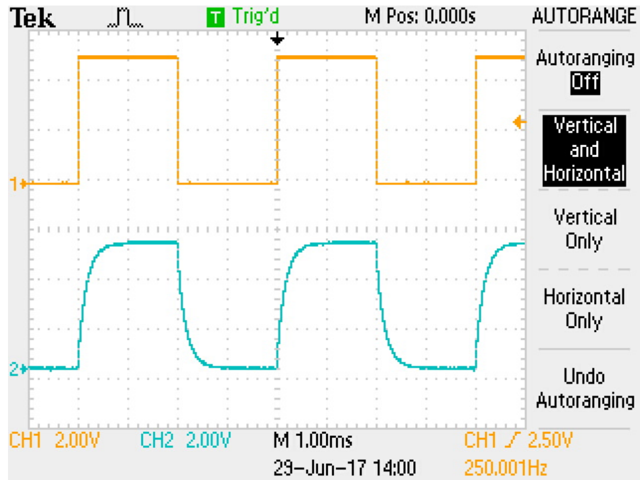

Fig. 2. The waveform of input and measure

TABLE I
Measurements of the Output Signal

name	value
period	4.000ms
max voltage	5.120V
min voltage	0.000V
time of $10\% V_{out}$ (LH)	16.0μs
time of $90\% V_{out}$ (LH)	364μs
time of $50\% V_{out}$ (LH)	116μs
time of $10\% V_{out}$ (HL)	$??\mu$s
time of $90\% V_{out}$ (HL)	$??\mu$s
time of $50\% V_{out}$ (HL)	$??\mu$s

TABLE II
Measurements of the Output Signal

name	actual value	theoretical value	PE
rise time	348μs	$220\mu s$	58.2%
fall time	$??\mu$s	$220\mu s$	??%
delay time (LH)	116μs	$69\mu s$	68.1%
delay time (HL)	$??\mu$s	$69\mu s$	??%

a) Analysis 1:

After we connected the circuit in Graph 4.1.1 in the lab instruction, we detected a waveform on our oscilloscope. To calculate its time constant accurately, we need as many data as possible. According to the instruction, we recorded 10 points separately for the original circuit, two-stage and three-stage. When we were selecting our testing points, we tried to pick more where the voltage rose(or fell) more rapidly with time. Also, we noticed that the measurements were not stable on the oscilloscope if its value was too small, so we paused the screen on random to record a relatively accurate number.

When we were measuring the voltages and their according time, we used the Cursor whose type was time and took Channel 2 as its source. We settle one of the cursor at start point of a rising or falling action, and moved the other cursor slightly. We also scaled the width of the waveform to get a more accurate move.

Our recordings for the original circuit are shown in the table below.

No	Voltage(V)	time(ms)
1	0.512	16.0
2	0.880	32.0
3	1.20	44.0
4	1.52	60.0
5	1.92	80.0
6	2.28	100
7	2.56	116
8	2.60	124
9	3.68	216
10	4.61	364

b) Experimental Results: Then we apply the data in Excel, we get a plot[3]:

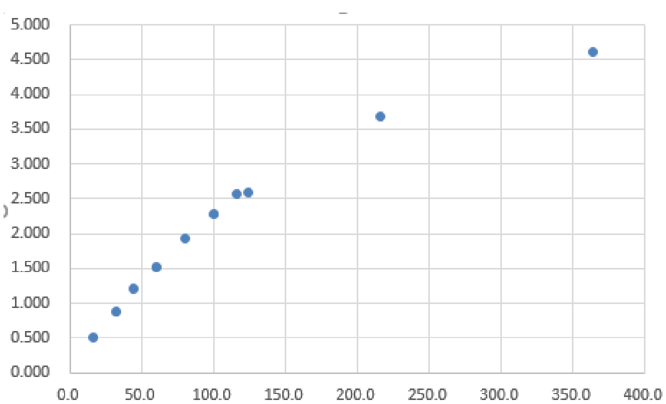

Fig. 3. plot on the Voltage of capacitor in the original circuit with time.

As the instruction suggested, we made the x-axis(time) into logarithmic and plot again[4] :

Then we fit a linear line to this plot, and we get a slope of 1.35. we get its inverse 0.74. Also, we calculated the theoretic value for τ and got

$\tau = RC = 10k\Omega * 0.01\mu F = 0.1ms$, which led to a % error.

c) Analysis 2:

To finish this analysis, we built a two-stage circuit and then a three-stage circuit. Our two-stage circuit is built according to graph[5]:

In the same way as in the original circuit, we measure 10 points to compute its time constant. We then get the time constant of two-stage $\tau =$.

And according to the circuit graph and some prelab exercise,

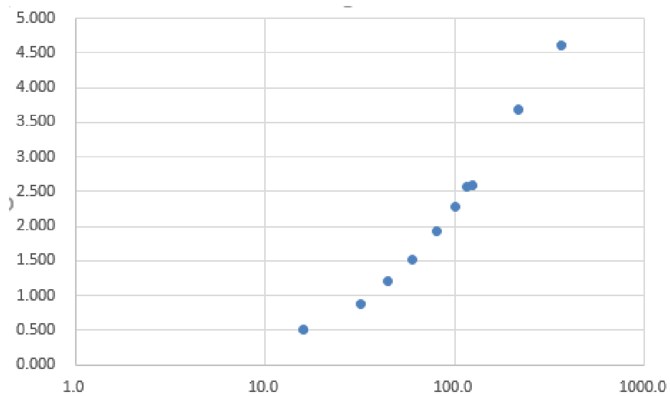

Fig. 4. plot on the Voltage of capacitor in the original circuit with logarithmic time.

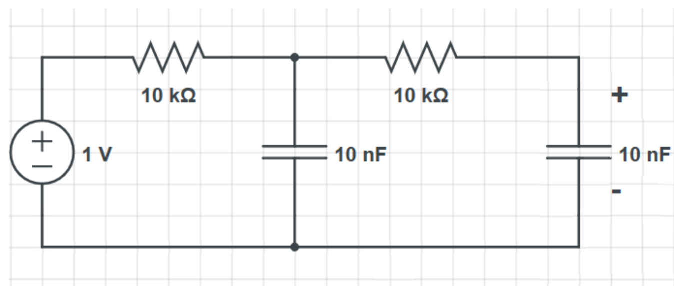

Fig. 5. the circuit graph of two-stage circuit

we can easily compute the theoretical value of time constant in this case:

$\tau =$ and the percent error $error = \%$.

Our three-stage circuit was built based on graph[6]

And our measure points are listed below:

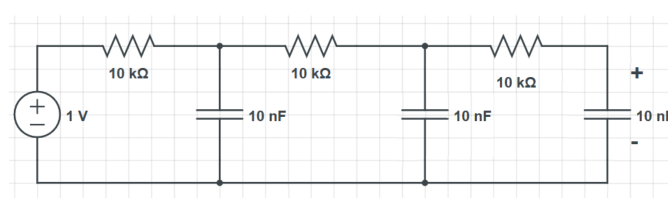

Fig. 6. the circuit graph of three-stage circuit

No	Voltage(V)	time(ms)
1	0.400	60.0
2	0.960	130
3	1.56	210
4	1.92	260
5	2.60	370
6	2.88	430
7	3.36	540
8	3.68	620
9	4.32	880
10	4.84	1330

We then get the time constant of three-stage $\tau =$.

No	Voltage(V)	time(ms)
1	0.560	0.0
2	0.720	140
3	1.20	270
4	1.68	400
5	2.32	580
6	2.64	680
7	3.08	850
8	3.56	1090
9	4.00	1380
10	4.28	1610

And according to the circuit graph and some prelab exercise, we can easily compute the theoretical value of time constant in this case:
$\tau =$ and the percent error $error = \%$.

B. The RC Response to a Sinusoidal Input

IV. Conclusions

V. Appendix