Thevnin Equivalents and Source Transformations
Circuits & Signals
EECE2150

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0 Introduction

Th purpose of this laboratory experimentation is to apply the concept of the Thevnin equivalent in real world scenarios. Additionally, this lab demonstrates the idea of source transformation.

1 Part I

1.1 Q1

The input resistance of the oscilloscope, measured using the ohmmeter, was approximately 1[MΩ].

1.2 Q2

The oscilloscope reads 2.5[V] across itself — equal to half of the input. This makes sense, because the oscilloscope resistance is roughly equal to the resistance of the resistor in parallel, as shown in figure 1.

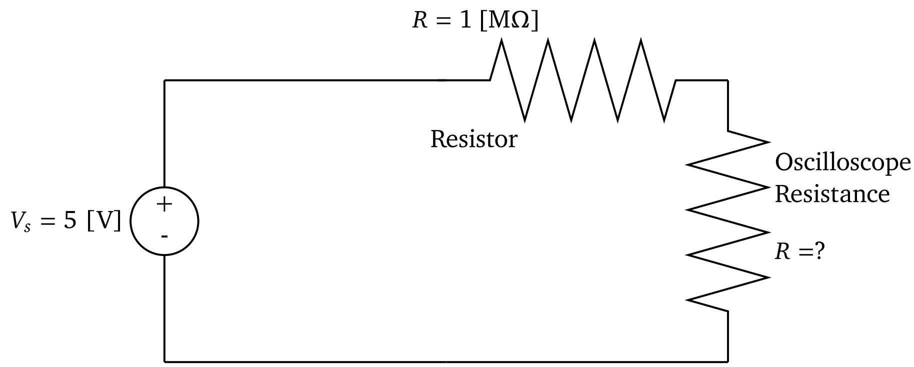


Figure 1: Oscilloscope Equivalent Circuit

2 Part II

2.1 Q3

The measurements taken (and R_{TH} calculation) are as follows:

- Open Circuit Voltage: 1[V]
- Output Voltage: ±.725[V]
- i_L: $\dfrac{.725}{100} = 7.25$[mA]
- $V_L = .275$[V]
- R_{TH}: $\frac{.275}{7.25} \cdot 100 = 37.93$[Ω]

2.2 Q4

The measurements with a 50[Ω] resistor are:

- Output Voltage: ±.525[V]
- i_L: $\dfrac{.525}{50} = 10.5$[mA]
- V_L: .475[V]

It makes sense that there is a lower output voltage, as the 50[Ω] resistor would receive more current and voltage, as compared to the 100[Ω] resistor.

3 Part III

3.1 Q5

To find the percent, one would calculate the ratio of the found resistance to the sum of the found resistance and oscilloscope resistance, times 100, as follows:

$$\frac{37.93}{37.93 + 10^6} \cdot 100 = .0038\%$$

3.2 Q6

Using the above formula, this would mean that:

$$\frac{R_{TH}}{R_{osc} + R_{TH}} \cdot 100 \leq 1$$
$$R_{TH} \leq .01(R_{osc} + R_{TH})$$
$$R_{TH} \leq .0101 R_{osc}$$

The oscilloscope needs a resistance of at least 99 times that of the Thevnin resistance.

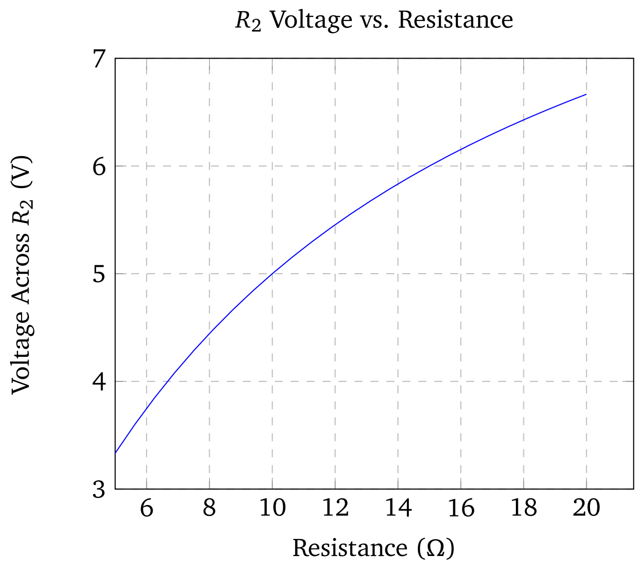
4 Source Transformation

4.1 Q7

The voltage across R_2 is 5[V]. This matches our voltage divider technique

4.2 Q8

The graph and table of R_2 values are shown below



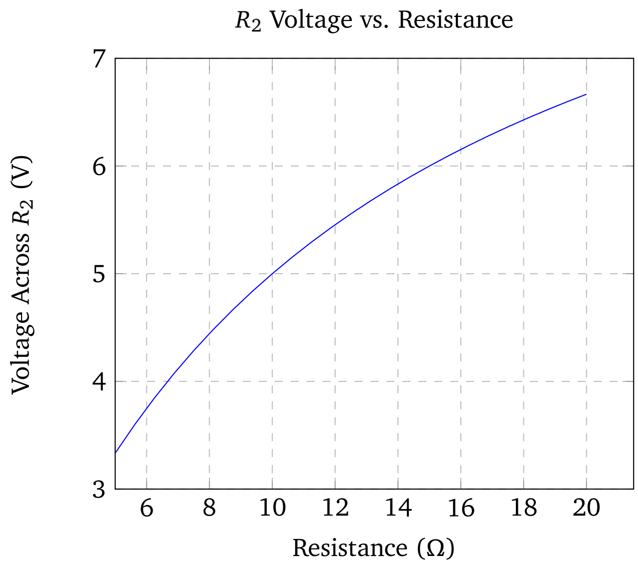
R_2 (Ω)	R_2 Voltage (V)
5	3.33
6	3.75
7	4.12
8	4.49
9	4.74
10	5
11	5.24
12	5.45
13	5.65
14	5.83
15	6
16	6.15
17	6.3
18	6.43
19	6.55
20	6.67

4.3 Q9

Despite the source transformation, the voltage across R_2 is the same as in the previous question

4.4 Q10

The values are the same as above, and are shown below:



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18	6.43
19	6.55
20	6.67

4.5 Q11

The two graphs are identical due to the source transformation performed

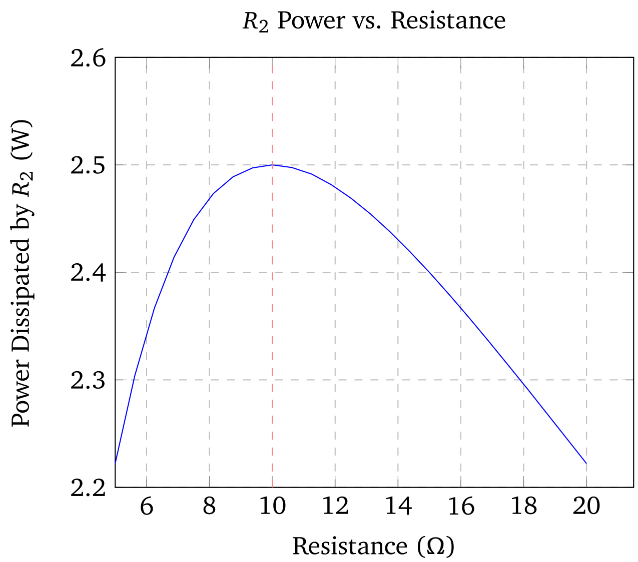
4.6 Q12

The power dissipated by R_2 is equal to:

$$5[V](.5[A]) = 2.5[W]$$

4.7 Q13

The graph for power dissipated by R_2 is as follows:



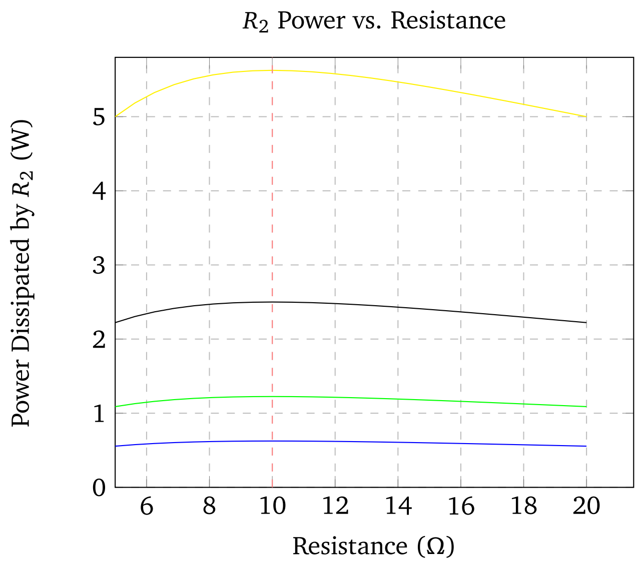
R_2 (Ω)	R_2 Power (W)
5	2.22
6	2.34
7	2.42
8	2.47
9	2.49
10	2.5
11	2.49
12	2.48
13	2.46
14	2.43
15	2.4
16	2.37
17	2.33
18	2.3
19	2.26
20	2.22

4.8 Q14

The graph rises up until roughly $R_2 = 10[\Omega]$ and then falls. This means that $R_2 = 10[\Omega]$ is a local maxima.

4.9 Q15

A graph with $V = 5, 7, 10,$ and $15[V]$ looks as follows:



The plots all have maximums at $10[\Omega]$. This is most likely because, at this value, the voltage splits most uniformly between the two resistors.

5 Conclusion

Overall, this laboratory experiment allowed us to determine the Thevnin equivalent circuit of the classroom oscilloscope. In doing so, the concept of Thevnin equivalents was demonstrated to us through real world means. On top of this, the correctness of source transformation was confirmed.