Introduction

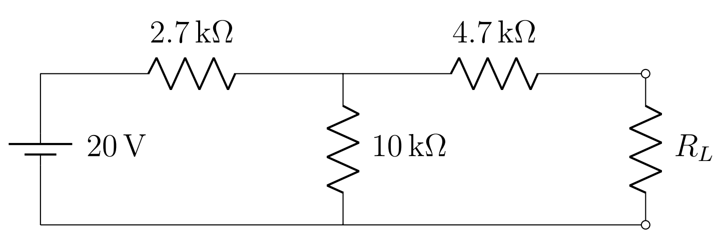
Lab Goals

1. Understand Thevenin's equivalent circuit
2. Understand Norton's equivalent circuit
3. Understand how a circuit changes under variable load
4. Get a better understanding for open circuit and closed circuit measurements
5. To develop, construct, and test the performance of the Thevenin's equivalent circuit of a two-terminal source network
6. To examine the effects of load variations on the voltage, current, power, and power-transfer efficiency the source-load-interface

Procedure

1. Connect the circuit shown in the figure below. Use a **decade resistor box** as the variable load $\mathbf{R}_L$. Connect the two DMM to the circuit; one to measure the load voltage $\mathbf{v}_L$, and the other to measure the load current $\mathbf{i}_L$

   Adjust the value of $\mathbf{R}_L$ to set the load voltage $\mathbf{v}_L$ at each value listed in table 1 and record the values corresponding of $\mathbf{i}_L$.



2. Use the data gathered in table 1 to plot $\mathbf{i}_L$ vs $\mathbf{v}_L$. Use this plot to evaluate the Thevenin's voltage $\mathbf{V}_{TH}$ and the resistance $\mathbf{R}_{TH}$ for the equivalent circuit of the source network. Values are found in the data analysis portion of this lab.
3. Replace the source network in your circuit by its **Thevenin's equivalent circuit**, and repeat as in step # 1. Record your measurements in table 2.
4. Adjust the settings of the decade resistance box $\mathbf{R}_L$ to provide each of the resistance ratios shown in table 3. For each setting measure the load voltage $\mathbf{v}_L$ and the current $\mathbf{i}_L$, and the load power $\mathbf{P}_L$, the source power $\mathbf{P}_s$, and the efficiency of power transfer $\eta\%$. Record your results in table 3.

Data

Table 1: Measured Loadline Values

$\mathbf{v}_L$	**0**	**4**	**6**	**8**	**10**	**12**
$\mathbf{i}_L$**(ma)**	2.383	1.786	1.488	1.189	0.892	0.595

Values found for step 2 in the procedure was,

$$\mathbf{V}_{TH} = 15.987\text{V} \qquad \mathbf{R}_{TH} = 6.745\text{k}\Omega$$

Table 2: Measured Loadline Values using Thevenin's Circuit

$\mathbf{v}_L$	**0**	**4**	**6**	**8**	**10**	**12**
$\mathbf{i}_L$**(ma)**	2.348	1.786	1.474	1.185	0.894	0.604

Table 3: Effects of Load Variation

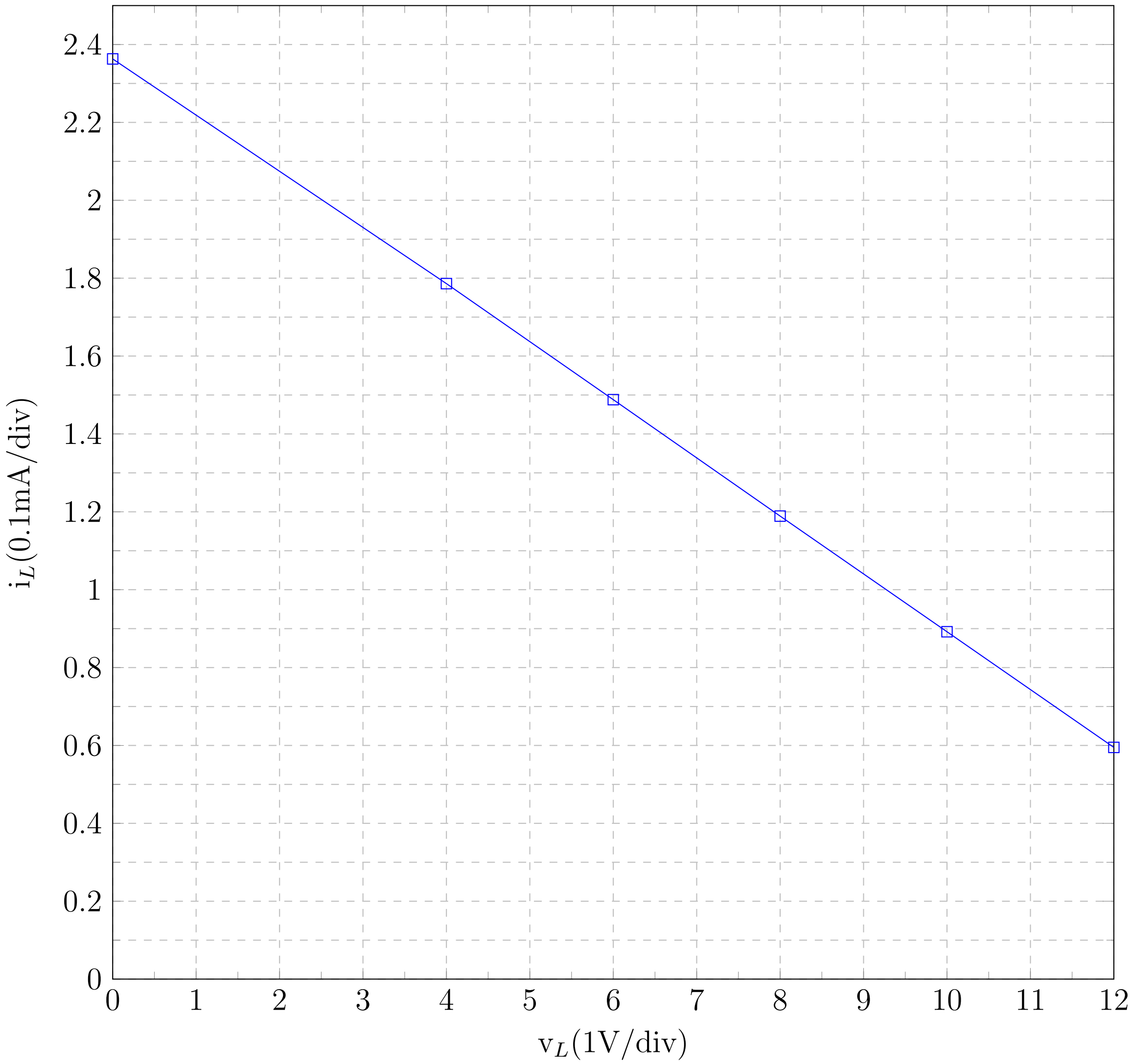
$\mathbf{R}_L/\mathbf{R}_{TH}$	**0.05**	**0.1**	**0.2**	**0.5**	**1.0**	**2**	**5**	**10**	**50**
$\mathbf{v}_L$**(V)**	0.752	1.44	2.64	5.29	7.97	10.68	13.40	14.64	15.82
$\mathbf{i}_L$**(mA)**	2.24	2.14	1.96	1.58	1.19	0.78	0.40	0.22	0.05
$\mathbf{P}_L$**(mW)**	1.68	3.07	5.18	8.35	9.48	8.50	5.36	3.22	0.79
$\mathbf{P}_s$**(mW)**	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
$\eta\%$	4.43	8.1	13.9	22.03	25.0	22.7	14.1	8.50	2.10

For η we will be using the formula,

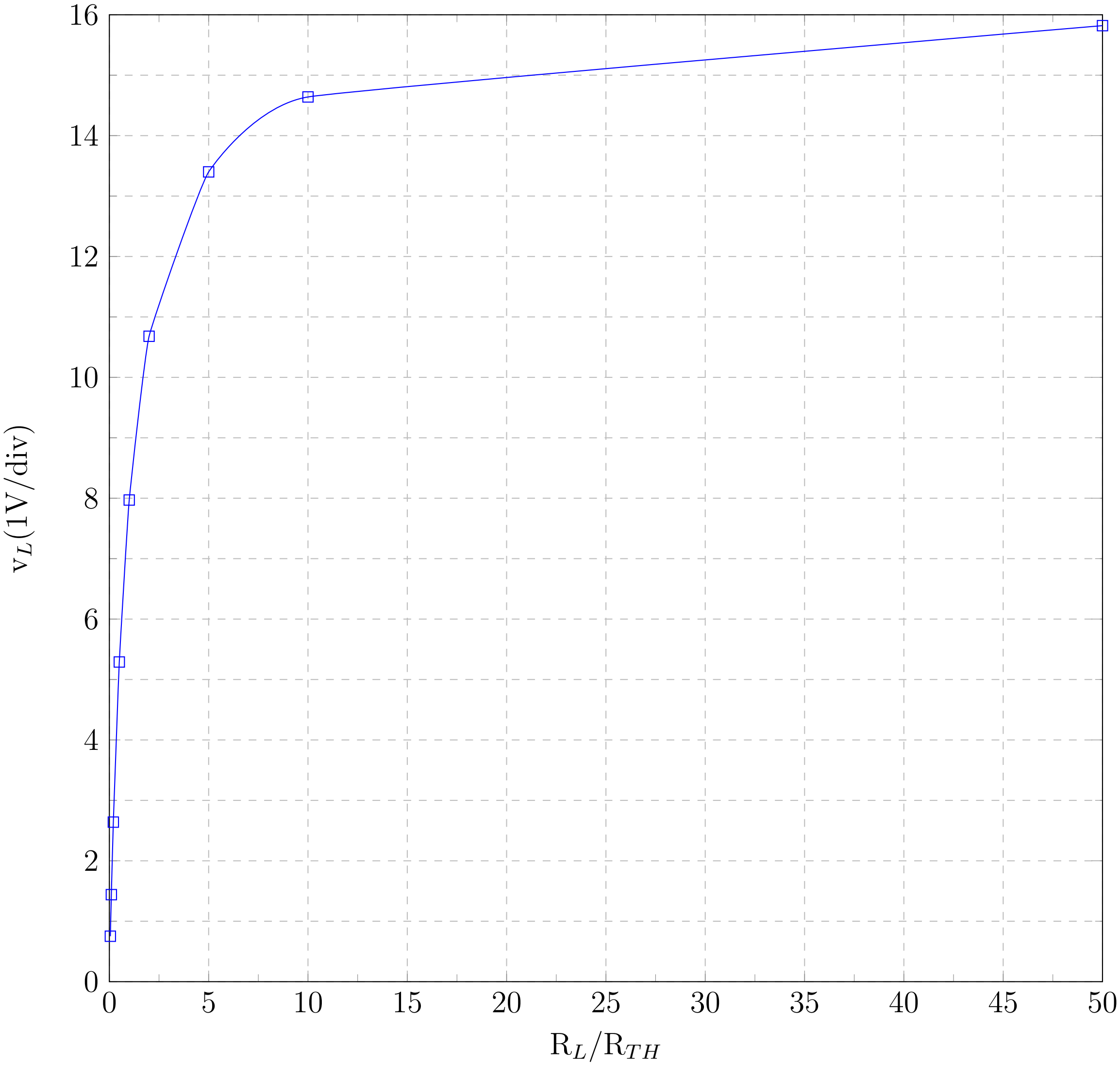
$$\eta\% = [P_L/P_S] \cdot 100$$

The following pages are the graphs for each of the tables.

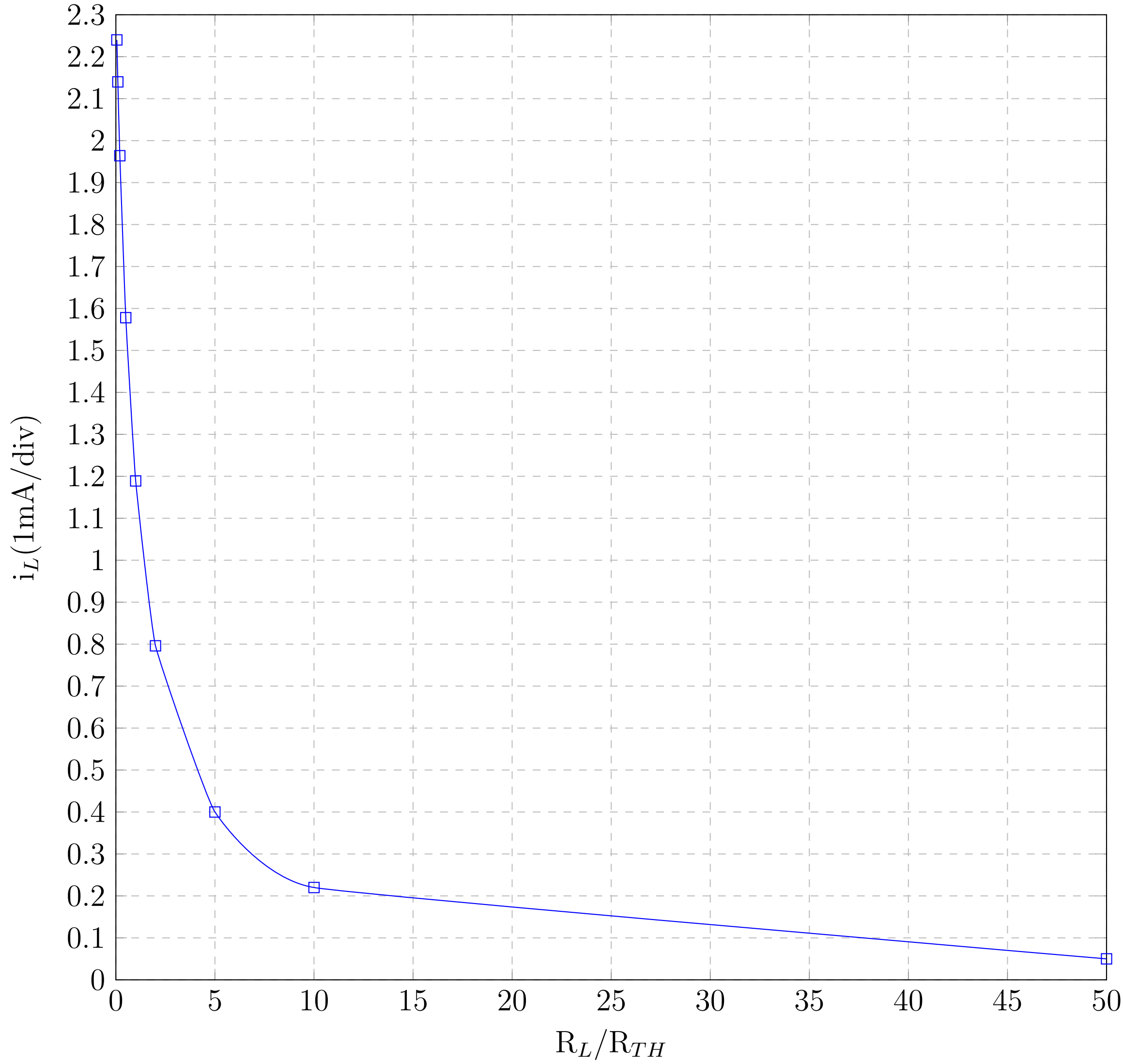
Graph 1: Load Current vs Load Voltage from table 1

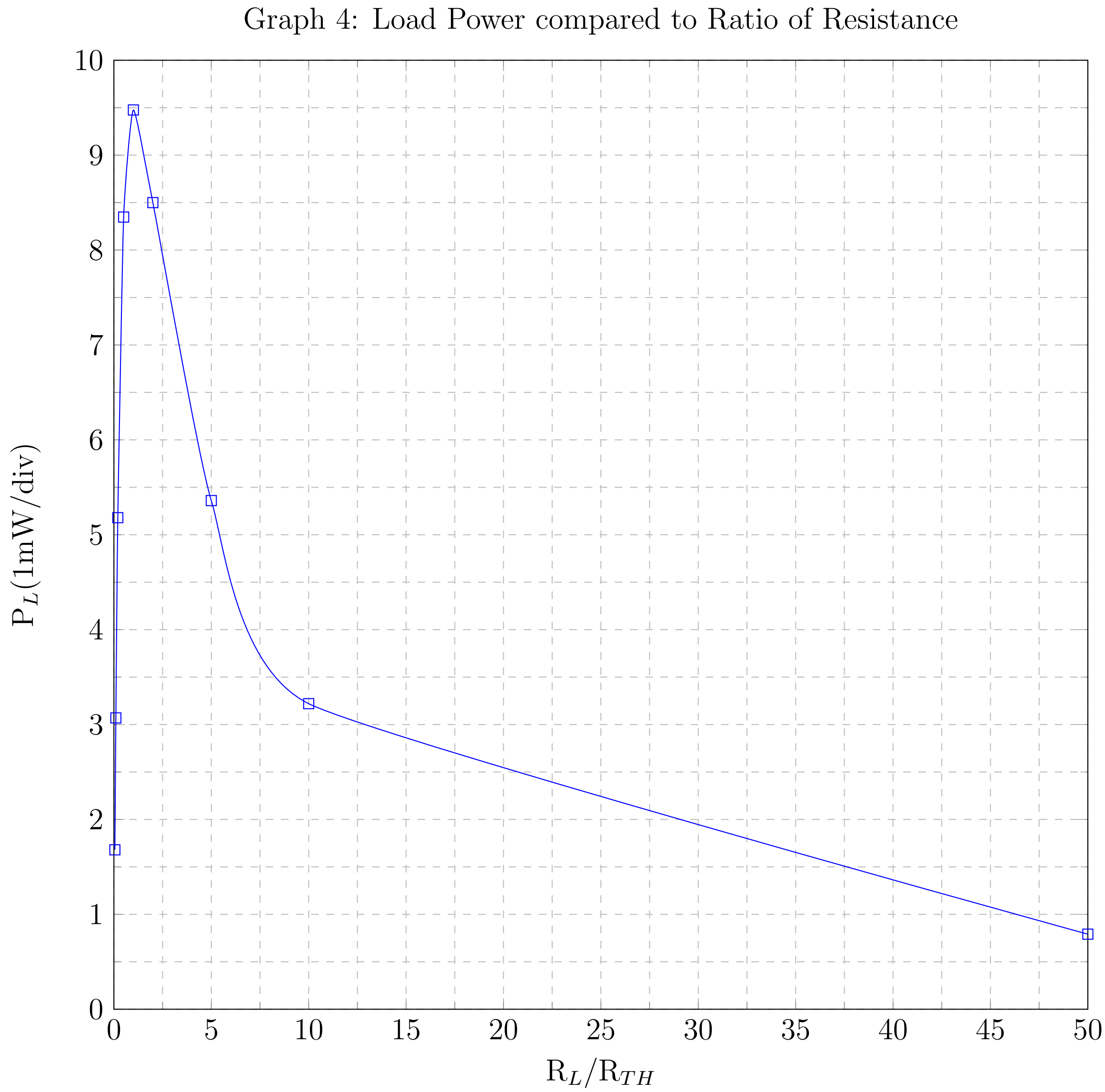


Graph 2: Load Voltage compared to Ratio of Resistance



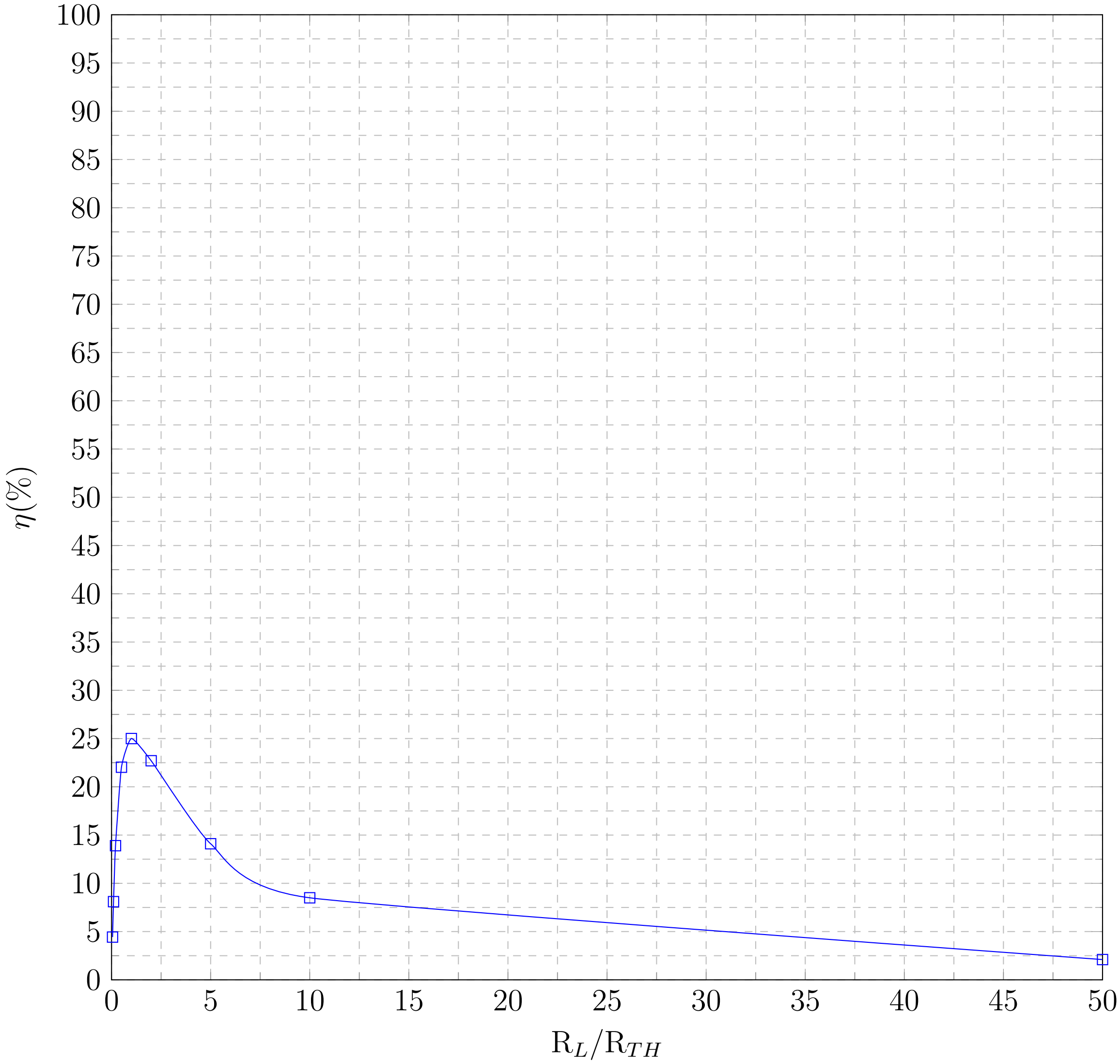
Graph 3: Load Current compared to Ratio of Resistance



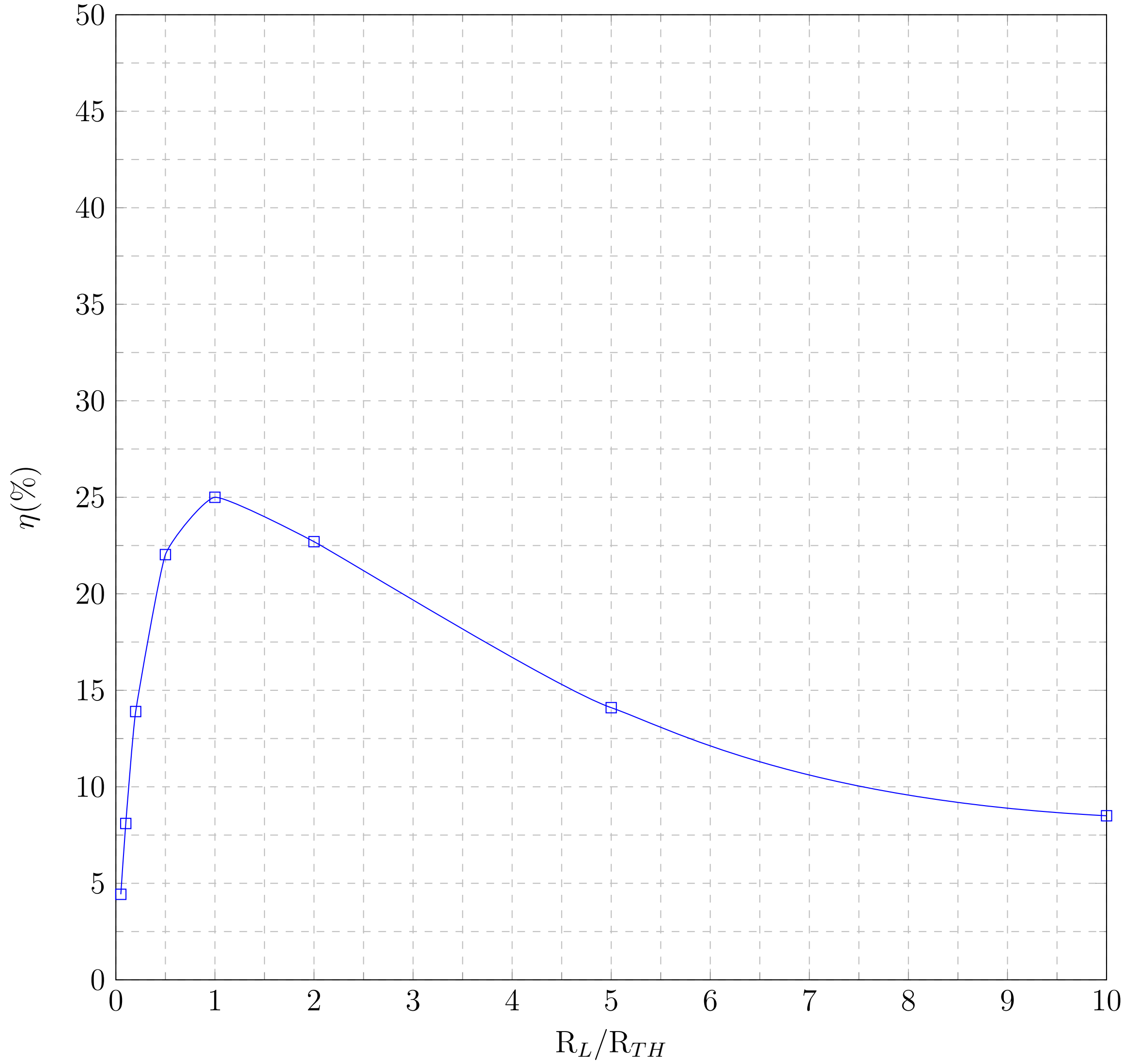


Graph 4: Load Power compared to Ratio of Resistance
P_L(1mW/div)
R_L/R_{TH}
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35
40
45
50

Graph 5: Efficiency of Power Transfer



Graph 6: Efficiency of Power Transfer Zoomed in



Conclusion

1. Comment on how the "measured" load line on graph 1, compare with the theoretical version. Discuss any discrepancies.

   The load line graph obtained through our measurements is similar to the theoretical load line. As the voltage is raised, the current at the same resistance would decrease, and so our graphs depicts a decreasing trend. Slight discrepancies include slightly different initial values, and the slopes may be similar but not exact. This can be accounted due to the idea that theory may be a good approximation to reality.

2. Discuss what you observed from the corresponding data recorded in tables 1 and 2.

   It is learned that current and resistance are inversely proportional as long as voltage stays constant. Raising the resistance would cause the current to decrease and decreasing the current we notice the current decreases. The graphs agree with Ohm's Law.

3. Discuss what you observed from the plots 2-5.

   Altering the ratio of resistance would cause the voltage graph to resemble that of the function $f(x) = \ln(x)$ shifted up. Likewise, as we increase the ratio of resistance we find the current resembles that of $f(x) = e^{-x}$. The power reaches a maximum point at a certain ratio of resistance but starts to decrease as the ratio increases. The ratio of resistance versus efficiency of power transfer represents a similar graph to power versus the ratio.

4. What is te range of values for R_L/R_{TH} that provide a combination of "almost" optimum power transfer to the load at a reasonably high power efficiency?

   The range from about 0.5-1.5 showed the highest efficiency.