GENERAL PHYSICS LAB 2 - PHYS112

Experiment 2: Impedance Matching and Internal Resistance

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Section: 7

(1)Abstract:

Aim of the experiment:

To calculate the internal resistance of the voltage source (8 volts), and find the loading resistance at the maximum power.

The Methods used:

By changing the values of "Load Resistance"(by the variable resistance in the circuit - decade box-), then reading the different measurements of the current that passing this circuit.

The main result is:

$R = 1000\,\Omega$

$(Y - intercept) = 0.1248\,(mA^{-1})$, $\varepsilon = 7.14\,Volts$, $r_{in} = -86.08\,\Omega$

$P_{max} = 16.0525(mW)$, $RL_{max} = 1050\,\Omega$, $r_{in} = 50\,\Omega$

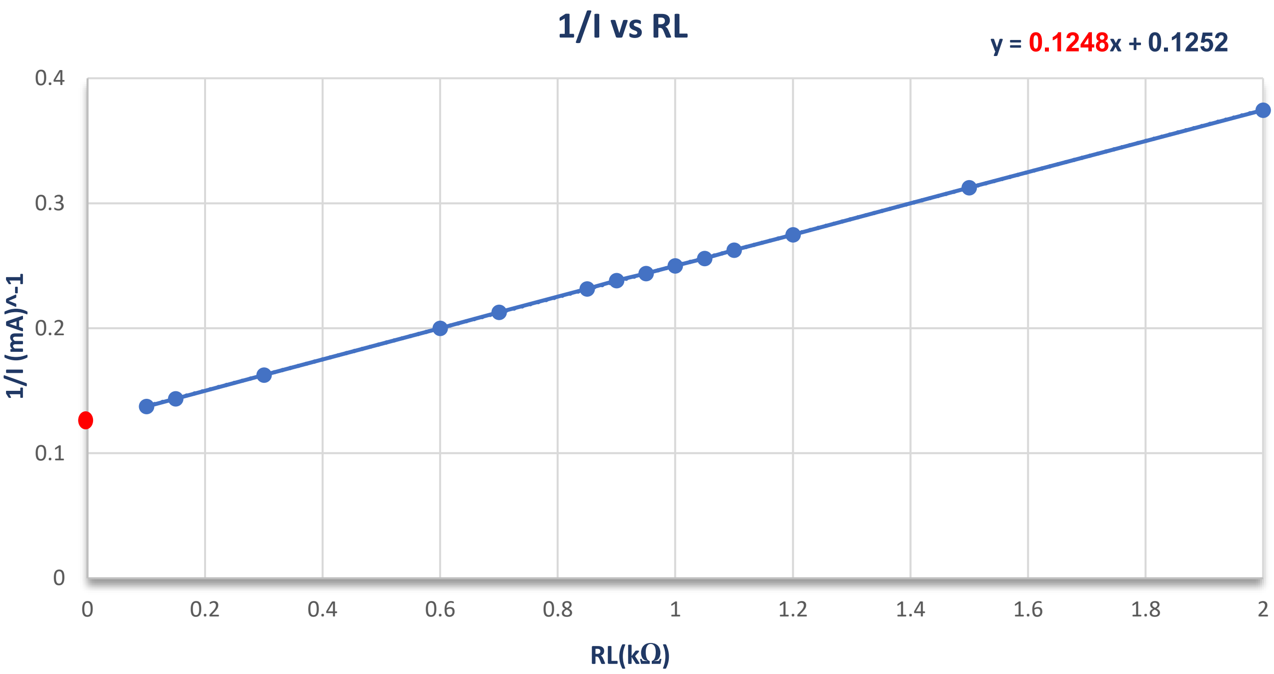
(2)Data:

Set V power supply = 8 Volts

R_L (KΩ)	I(mA)	I^{-1} $(mA)^{-1}$	I^2 $(mA)^2$	$P_L = I^2 R_L$ (mW)
0.10	7.28	0.137	52.99	5.29
0.15	6.96	0.144	48.44	7.27
0.30	6.15	0.163	37.82	11.35
0.60	5.00	0.020	25.00	15.00
0.70	4.70	0.213	22.09	15.46
0.85	4.32	0.232	18.66	15.86
0.90	4.20	0.238	17.64	15.88
0.95	4.10	0.244	16.81	15.97
1.00	4.00	0.250	16.00	16.00
1.05	3.91	0.256	15.29	16.05
1.10	3.81	0.262	14.52	15.97
1.20	3.64	0.275	13.25	15.89
1.50	3.20	0.313	10.24	15.36
2.00	2.67	0.375	7.13	14.26
3.00	2.00	0.050	4.00	12.00
4.00	1.6	0.625	2.56	10.24
8.00	0.88	1.136	0.774	6.19
15.0	0.49	2.041	0.240	3.60
30.0	0.25	4.000	0.0625	1.88
60.0	0.12	8.333	0.0144	0.86

(3) Calculations and Graphs:

1- (I^{-1} vs RL):



$\circledast$ $Y - intercept = 0.1248\ (mA^{-1})$

$\circledast$ **The slope at $(0.1, 0.137)$ and $(0.15, 0.144)$:**

$$slope = \frac{\Delta(I^{-1})}{\Delta(RL)} = \frac{1}{\varepsilon} = \frac{0.144 - 0.137}{0.15 - 0.1} = 0.14\ \ (Volts^{-1})$$

$$\varepsilon = \frac{1}{slope} = \frac{1}{0.14} = 7.14\ (Volts)$$

$\varepsilon = 7.14\ \ (Volts)$

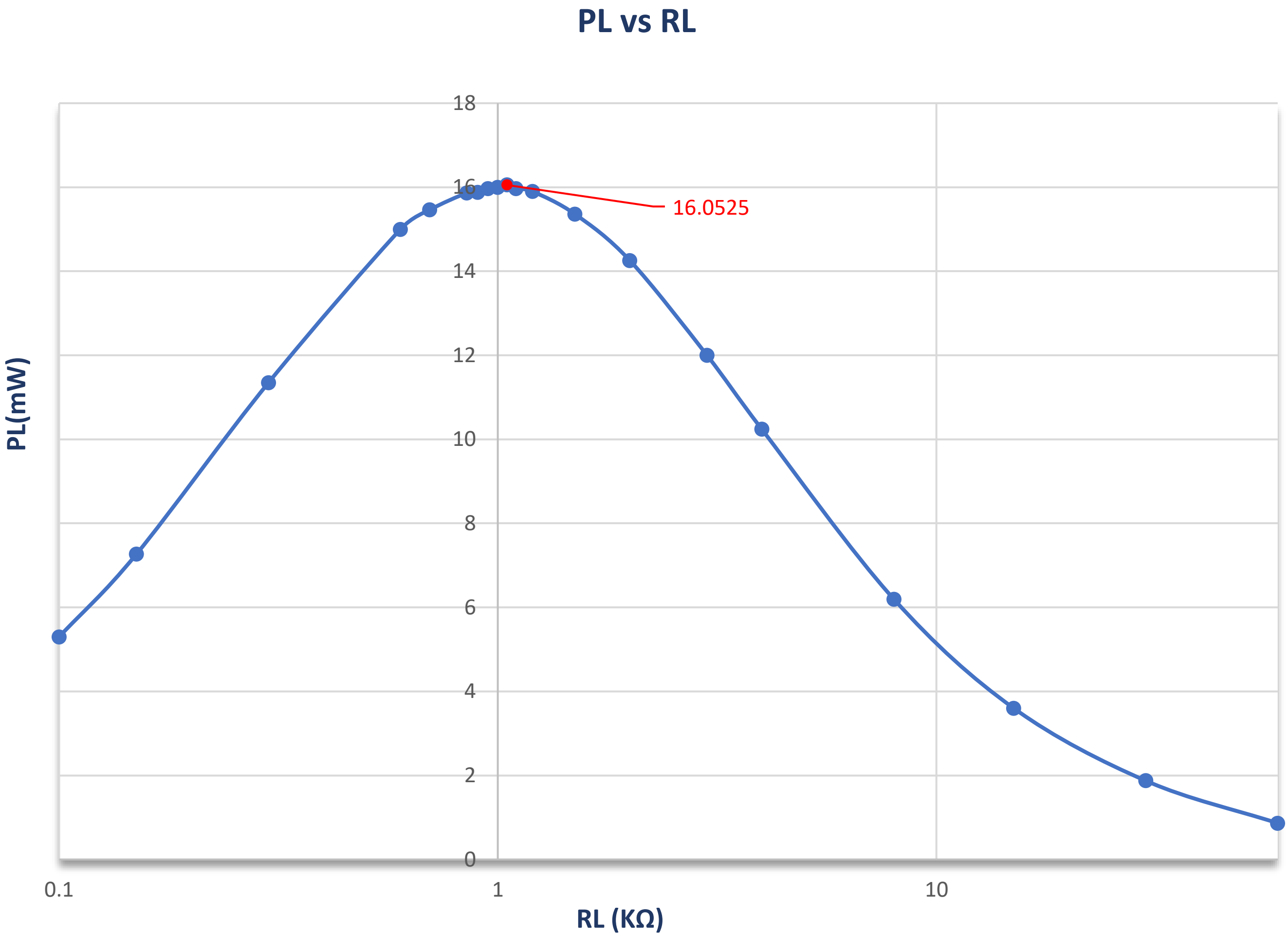
$R \approx 1000\Omega$

$\circledast$ $\varepsilon \times (Y - intercept) = R + r_{in}$

$$7.14 \times (0.1248 \times 10^3) = 1000 + r_{in}$$

$r_{in} = -86.08\ \Omega$

2- ($PL\ vs$ RL)



$- \boldsymbol{The\ maximum\ value\ of\ power = 16.0525(mW)}$

$- \boldsymbol{We\ find\ the\ maximum\ value\ of\ (RL\ =\ 1.05\ K\Omega\ =\ 1050\ \Omega)}$.

$\boldsymbol{RL = R + r_{in}}$

$\boldsymbol{1050 = 1000 + r_{in}}$

$\boldsymbol{r_{in} = 50\ \Omega}$.

(4) Conclusions:

This experiment highlighted the significance of impedance matching for maximizing power transfer efficiency in electric circuits.

By charging load resistances and analyzing corresponding currents, we noticed the impact of internal resistance on power dissipation, also we noticed that when $(\mathbf{RL} = \mathbf{R} + \mathbf{r}_{\mathbf{in}})$, RL should be at the maximum value then we calculated it from graph 2 ⋙⋙ $(\boldsymbol{RL} = \mathbf{1050}\ \Omega)$.

When we calculated $\boldsymbol{r_{in}}$, we noticed that the value of internal resistance that we calculated doesn't equal that total of resistance, this is because the $\boldsymbol{r_{in}}$ in a voltage source is small $(\mathbf{few\ ohm's})$.

At the beginning of the experience, we set V power supply = 8 volts, and we calculated it from the graph 1 ⋙⋙ $(\boldsymbol{\varepsilon} = \mathbf{7.14}\ \boldsymbol{Volts})$, this difference between two values of $\boldsymbol{\varepsilon}$ is acceptable due to the voltage "small value" come from the internal resistance $(\boldsymbol{r_{in}})$.