BIRZEIT UNIVERSITY
Physics Department

Physics 112

Experiment No. 2

Impedance Matching and Internal Resistance

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➢ Abstract :

- **The aim :** To find the value of the load resistance R_L that satisfies the condition of the maximum power transfer which is $R_L = R + r_{in}$.

- **The method :** The direct calculation of the electrical current passing through a simple circuit at different values of the resistance so we start making the circuit and connecting their elements with each other, we connect a battery that have a voltage of a 10 volts "Є" with a constant resistor of 1000 Ω "R" and then connect the constant resistor with the adjustable resistor "RL" that is the load resistor.

- **The main Result :**

  - **From graph 1 (1/I vs RL):**
    Slope of line = 1/E = 0.0996.
    E = 1/Slope = 10.03 volt .
    y-intercept = ∑R/E = 0.092 mA^{-1} = 92.6 A^{-1}.
    ∑R = (R + rin) = 922 Ω .

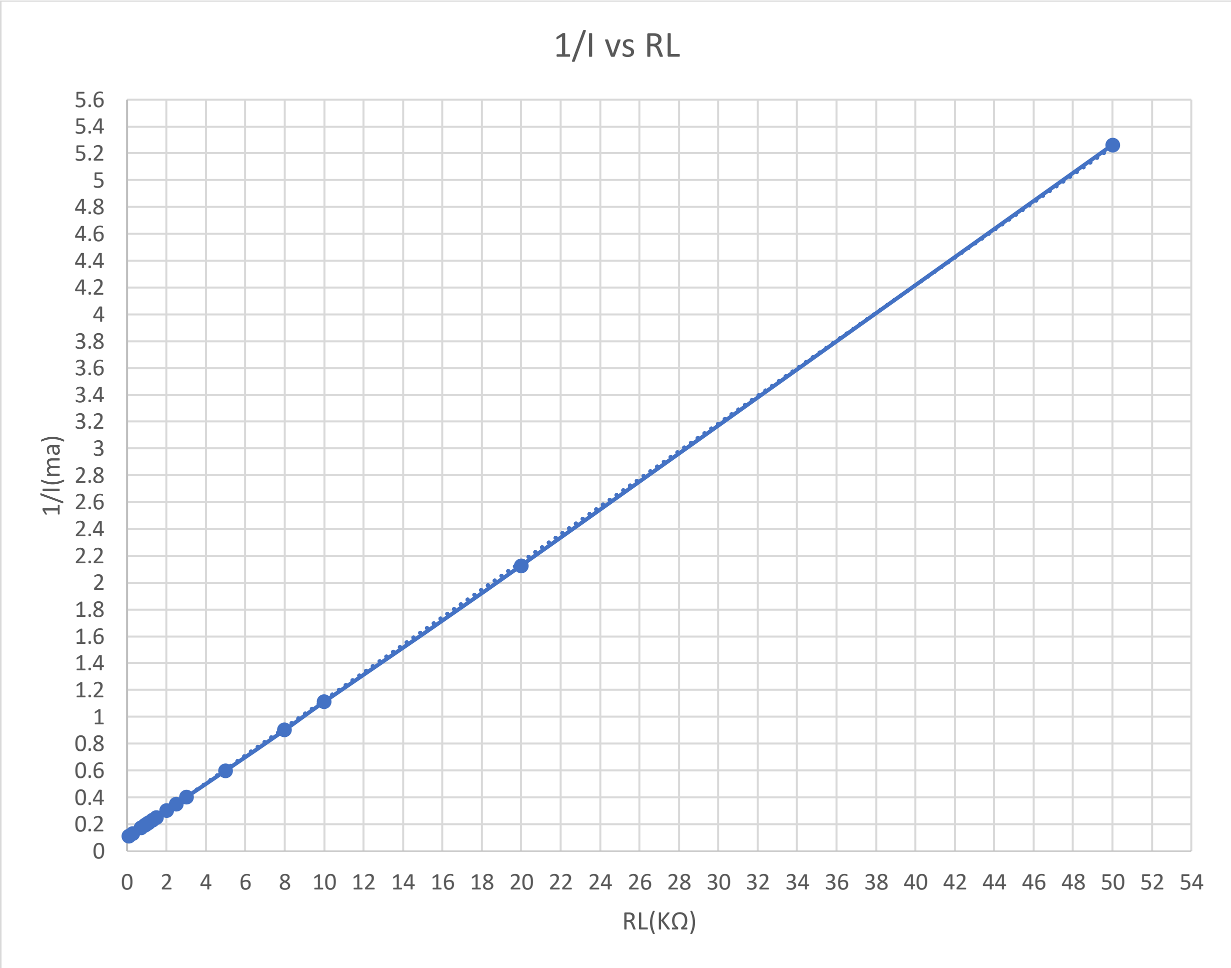
  - **From graph 2 (P vs RL) :**
    P_{max} = 24.9001 mW.
    RL = (R + r_{in}) = (1 K Ω) = 1000 Ω.

- **Introduction :**
  A voltage source is characterized by its electromotive force and the maximum value of the current it can deliver to short circuit .
  In this experiment, it was expected to measure the internal resistance of the voltage, the potential difference , and the maximum value of the power. This would be done by graphing two graphs, where one is expected to be a linear graph of R_L vs I^{-1}, and the second is expected to have a graph where the maximum value of the power, is known.

➢ Data

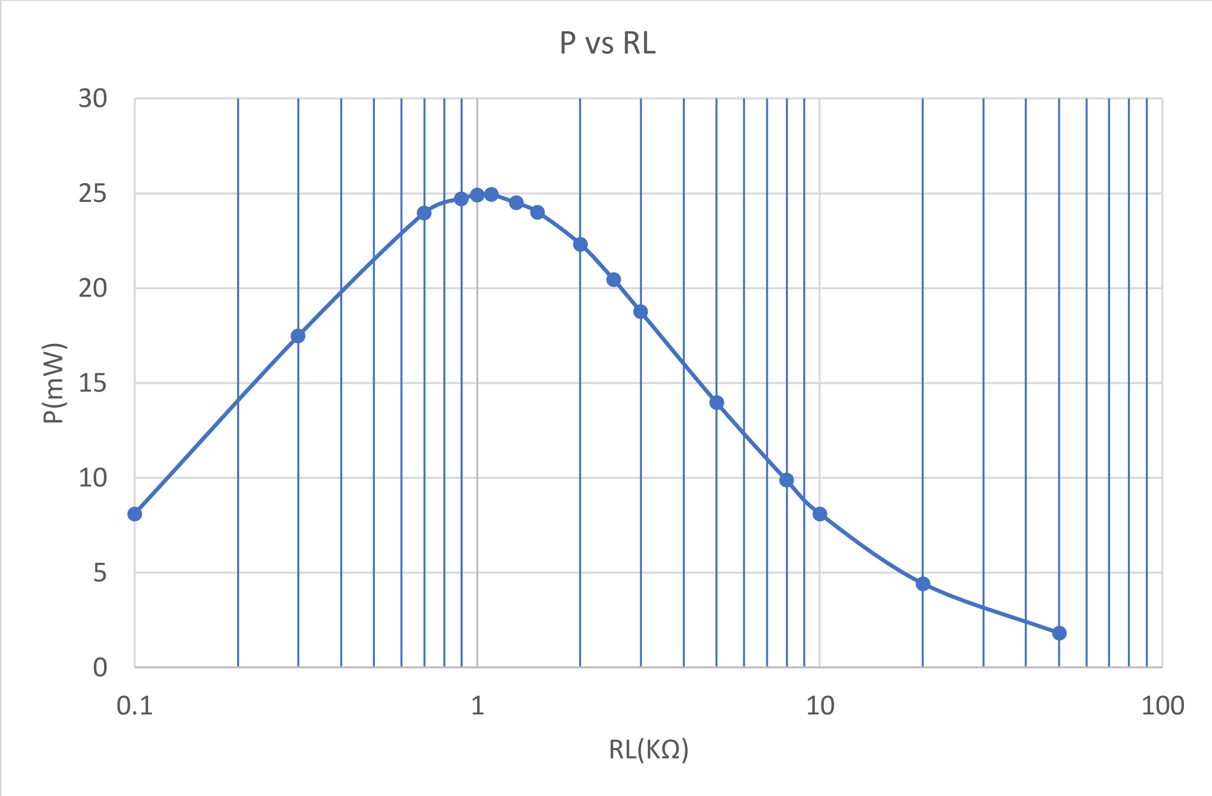
R_L (K)	I(ma)	I^{-1}	I^2	$P_L = I^2 R_L$
0.1	9	0.11111111	81	8.1
0.3	7.63	0.1310616	58.2169	17.46507
0.5	6.62	0.1510574	43.8244	21.9122
0.7	5.85	0.17094017	34.2225	23.95575
0.9	5.24	0.19083969	27.4576	24.71184
1	4.99	0.2004008	24.9001	24.9001
1.1	4.75	0.21052632	22.5625	24.81875
1.3	4.34	0.23041475	18.8356	24.48628
1.5	4	0.25	16	24
2	3.34	0.2994012	11.1556	22.3112
2.5	2.86	0.34965035	8.1796	20.449
3	2.5	0.4	6.25	18.75
5	1.67	0.5988024	2.7889	13.9445
8	1.11	0.9009009	1.2321	9.8568
10	0.9	1.11111111	0.81	8.1
20	0.47	2.12765957	0.2209	4.418
50	0.19	5.26315789	0.0361	1.805

➢ Data Analysis :



✓ Calculations of Graph 1 :

- Slope = $\dfrac{\Delta 1/I}{\Delta R}$ = $\dfrac{0.4 - 0.131}{3 - 0.3}$ = 0.0996
- E = 1/(Ans before rounding) = 10.03 volt.
- y-intercept = ∑R/E = 0.092 mA^{-1} = 92.6 A^{-1}.
- ∑R = (R + r_{in}) = y-intercept * E = (0.092 * 10.03) = 0.9227 volt / mA =922Ω .
- r_{in} =∑R - R (where R is 1KΩ making it 1000).
  r_{in} = 922 – 1000 = -78 Ω .



✓ Calculations of Graph 2 :

- We see from figure (power versus resistance) that the maximum value for p occurs at RL equal (1) KΩ $\Rightarrow$ p_{max} equal (24.9001) mW .

- **And the maximum power is when :**
  R_L = (R+ r_{in}) = (1k KΩ) = (1000 Ω).
  R_{in} = RL – R = 1000 – 1000 = 0 Ω

➢ Result and conclusion :

- There should be an internal resistance in every circuit .
- To reach the maximum value of the power transferring the load resistance should be equal to the sum of the additional resistance and the internal resistance.
- Our Result of (R+ r_{in}) from Linear graph = 922 Ω and (R+ r_{in}) from semi log = 1000 Ω .
  We noticed that difference in values of (R +rin) that occurred due to Systemetic errors and random errors.