بكار

Experiment 2

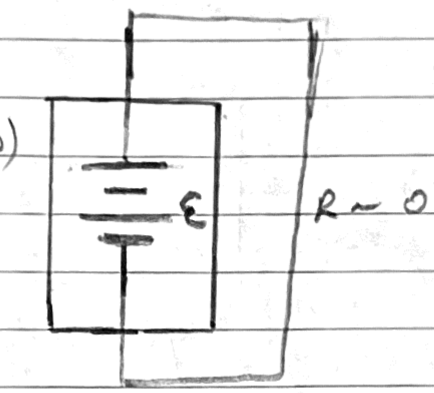
Source internal Resistance, Loading problems and circuit impedance matching.

* electromotive force (ε) القوة الدافعة الكهربائية : it is the open circuit voltage difference between its terminals, or it is the voltage difference between terminals of an open circuit.

* An ideal voltage source connected to a short circuit ($R \sim 0$) should according to ohm's law be able to provide an almost infinite current

ohm's law

$$I = \frac{\varepsilon}{R} \simeq \infty \quad (R \sim 0)$$



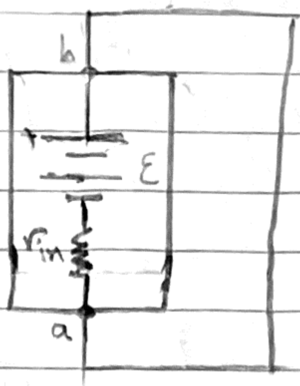
ideal battery or source

* In real circuits a voltage source connected to a short circuit can neither maintain its (emf) as a voltage difference across its terminals nor can it provide the circuit with unlimited current

في الدارات الحقيقية ان توصل مصدر جهد مع short circuit ($R \sim 0$)
لا يستطيع المحافظة على القوة الدافعة الكهربائية كمصدر جهد بين طرفيه
ابدا ولا يستطيع ان يزود الدارة بتيار لا محدود

⇒ Therefore, each real voltage is assigned an internal resistance (r_{in})

سلم بجار



real battery or real source
⇓
has an internal resistance

$V_{ab} \simeq \mathcal{E}$ for small r_{in}

⇒ Fig gives more realistic representation of a voltage source

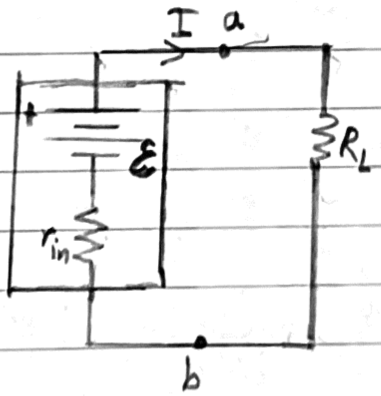
- The voltage sources with small internal resistance can maintain most of their emf as a voltage difference between their terminals

⟹ so provide circuit with higher current values than would the ones with high internal resistance.

* Load: any component which consumes electrical power to produce useful work

⇒ and the resistance of such a component is called Load resistance (R_L)

* Loading happens when r_{in} is comparable to R_L
  مشابه او مماثل



The current passing through the simple series circuit is ⇒

$$\boxed{I = \frac{\mathcal{E}}{R_L + r_{in}}}$$

جهد

The voltage difference between the source terminals is :

$$V_{ab} = V_{RL} = I\,R_L$$

$$\Rightarrow \boxed{V_{R_L} = \frac{\varepsilon}{(R_L + r_{in})} R_L}$$

* If $R_L \gg r_{in}$ then $R_L + r_{in} \simeq R_L$ then

$$V_{RL} \simeq \frac{\varepsilon}{\cancel{R_L}} \cancel{R_L}$$

$$\Rightarrow \boxed{V_{R_L} \simeq \varepsilon} \Rightarrow$$ the source delivers most of its emf as a voltage difference across its terminals.

* If R_L is comparable to r_{in} ($R_L \simeq r_{in}$) then

$$V_{R_L} \simeq \frac{\varepsilon}{(R_L + R_L)} R_L$$

$$V_{R_L} \simeq \frac{\varepsilon}{2R_L} R_L$$

$$\Rightarrow \boxed{V_{R_L} \simeq \frac{\varepsilon}{2}}$$

كبيرة / الضخم

in this case considerable amount of power is consumed inside the source and converted to unuseful heat energy $\Rightarrow$ this case is said to be loaded.

* In practical circuits we want to avoid loading the source so we choose $R_L \geq 10\, r_{in}$

Impedance Matching (Maximum Power Transfer)
مواءمة

* In real circuits, power consumed in the load produce useful work ⟹ therefore we seek to consume the maximum available power there
نطلب

* The power consumed in the load resistor is

$$\boxed{P = I^2 R_L}$$

$$= \left(\frac{\mathcal{E}}{R_L + r_{in}}\right)^2 R_L$$

$$\Rightarrow \boxed{P = \frac{\mathcal{E}^2}{(R_L + r_{in})^2} R_L}$$

⟹ represents the power consumed in the load as a function of the load resistance itself.

* The function $P(R_L)$ has a maximum value which can be obtained by setting $\frac{dP}{dR_L} = 0$

$$\Rightarrow \boxed{R_L = r_{in}}$$

⟹ the condition for transferring maximum power to the load resistance

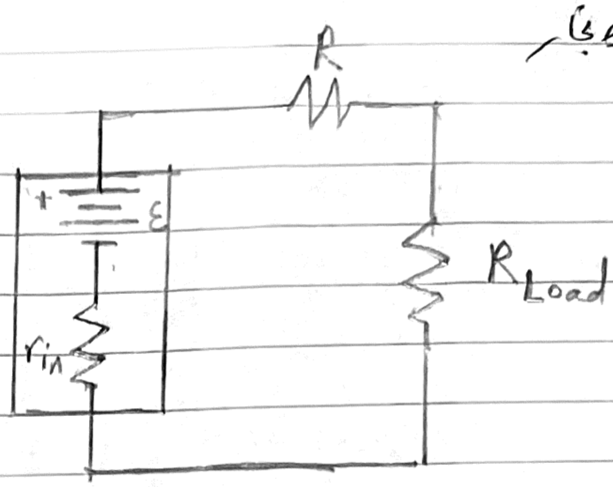
⟹ This choice of load resistance is called impedance matching.

* To achieve this condition with avoiding loading problem additional resistance R is added

⟹ this R helps in avoiding loading problem and fulfilling the condition of impedance matching for large load values.

سابقا

- The only disadvantage is that this additional resistance R consumes part of the power delivered to the circuit by the source.

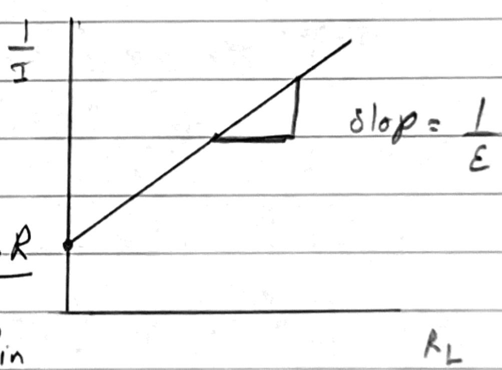


$$\boxed{I = \frac{\varepsilon}{r_{in} + R + R_L}}$$

$$\frac{1}{I} = \frac{r_{in} + R + R_L}{\varepsilon}$$

$$\boxed{\frac{1}{I} = \frac{R_L}{\varepsilon} + \frac{r_{in} + R}{\varepsilon}} \quad r_{in} + R = R_{in}$$

plotting $\frac{1}{I}$ vs R_L on a linear graph



Y-intercept = $\frac{r_{in} + R}{\varepsilon} = \frac{R_{in}}{\varepsilon}$

Find ε, R_{in} khnowing $R = 1\,k\Omega$ ⟹ you can find r_{in}

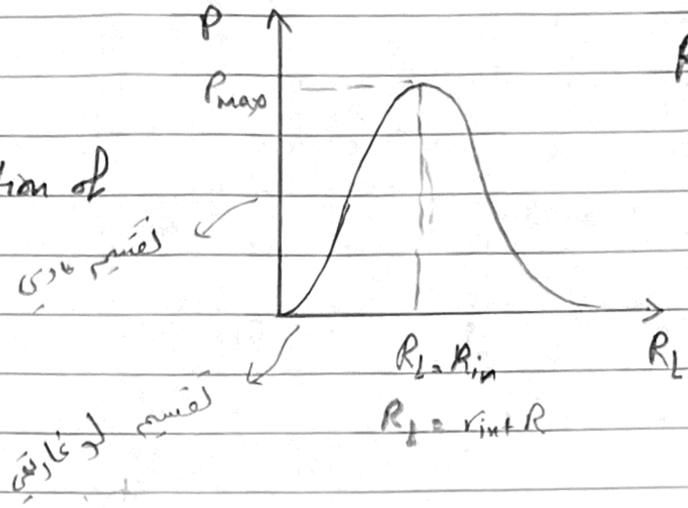
DM الأدق أن نحصل على قيمتها من
حيث تكون بحدود $983\,\Omega$

لمعطيات

Plotting P vs R_L on a semi-log graph paper

Find R_L that satisfies the condition of max power.

$P = R_L I^2$



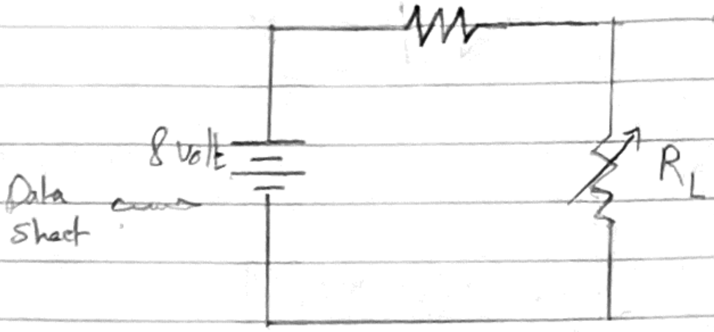
ساره بخار   خطوات العمل

a) Connect the circuit as in Fig

نقوم بتوصيل الداره كما في الشكل

$R = 1k\Omega \Rightarrow$ but we will take its value from DM

للحصول على نتائج أدق



b) chang R_L and record the value of current each time

غير قيم R_L تبعا لما في data sheet و سجل قيمه التيار المرافق لـ R_L في كل مره

c) Draw $1/I$ vs R_L on a linear graph to find the value of r_{in} and ε

$Y \text{ intercept} = \frac{R + r_{in}}{\varepsilon}$, $R = 1k\Omega$, ε : جهد المصدر

من قراءة الجهاز عوضنا ممكن تكون $983\ \Omega$

$\text{slope} = \frac{1}{\varepsilon}$

d) compute P for all values of I $\Rightarrow (P = R_L I^2)$

e) plote P vs R_L on a semi-log paper

At $P_{max} \Rightarrow R_L = R_{in} = r_{in} + R$

$\Rightarrow$ You can find R_L that satisfies the condition of maximum power transfer.

$r_{in} = R_L - R$

التي تحقق P_{max}

تقيسها بالضبط باستخدام DM للحصول على نتائج دقيقة تقريبا

983 اكثر او اقل حسب القطعة التي تقيسها