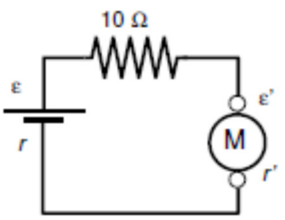
Retaking Second exam FFI
Recuperación 2º parcial FFI
January 26th 2018
Year-Curso 2017/18

Applied Physics Dept.
Dep. de Física Aplicada

1. (2,5 points) The motor on picture consumes **50 W**, a **10 %** of them by Joule heating on its internal resistor. The power supply supplies **60 W** to the circuit. Compute:
a) the consumed power on the **10 Ω** resistor.
b) if the power supply generates **64 W**, find its features: **ε**, ***r***
c) to finish, find the features of motor: **ε´**, ***r´***.

1. (2,5 puntos) El motor del circuito de la figura consume **50 W**, de los cuales un **10 %** es por efecto Joule. Si la fuente suministra **60 W** al circuito externo, determina:
a) la potencia consumida en la resistencia de **10 Ω**
b) si la fuente genera una potencia de **64 W**, determina sus características: **ε**, ***r***
c) por último, calcula las características del motor: **ε´**, ***r´***



a) The power consumed on 10 Ω is the difference between the power supplied by the battery and the power consumed by the engine: $P_{10}=60-50=10\,W$

b) From before computation, the intensity flowing along the circuit can be calculated: $P_{10}=10=I^2 10 \Rightarrow I=1\,A$

On battery $P_g=64=\varepsilon I$ As I=1 A $\varepsilon=\frac{64}{1}=64\,V$ On the other hand $P_s=60\,W$. Then, the power consumed on internal resistance of battery (r) will be $P_r=P_g-P_s=64-60=4=I^2 r$

As I=1 A, $r=\frac{4}{1}=4\,\Omega$

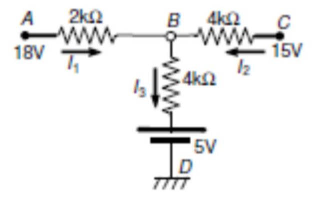
c) On engine, the power consumed on its internal resistance (r') is a 10% of consumed power $P_{r'}=\frac{10\cdot 50}{100}=5\,W$

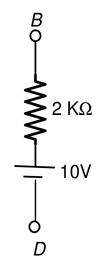
But $P_{r'}=I^2 r' \Rightarrow 5=1^2 r' \Rightarrow r'=\frac{5}{1}=5\,\Omega$

And the turned power will be a 90% of consumed power: $P_t=\frac{90\cdot 50}{100}=45=\varepsilon' I \Rightarrow \varepsilon'=\frac{45}{1}=45\,V$

2. (2,5 points) Given the circuit on picture
a) Find the intensities $\mathbf{I_1}$, $\mathbf{I_2}$, e $\mathbf{I_3}$ by using Kirchoff's rules.
b) Compute the **potential** at point **B**.
c) Compute the **Thevenin's equivalent generator** between points **B** and **D**, clearly showing its **polarity**.
d) If the lower branch is **connected** between points **B** and **D**, say if the element **10** V consumes or generates power, computing this power.

2. (2,5 puntos) Dado el circuito de la figura
a) Determina las intensidades de rama $\mathbf{I_1}$, $\mathbf{I_2}$, e $\mathbf{I_3}$ mediante las leyes de Kirchhoff.
b) Calcula el **potencial** en el punto **B**.
c) Calcula el **generador equivalente de Thevenin** entre los puntos **B** y **D**, indicando claramente su **polaridad**.
d) Si se **conecta** la rama inferior a **B** *y* **D**, indica si el elemento de **10 V** consume o genera potencia y calcula su valor.



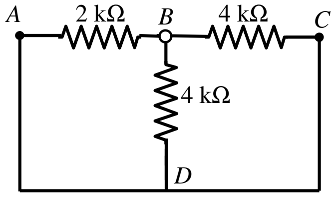


a) This is a network with 2 junctions and two loops, and so we'll need one equation for junctions and two equations for loops:

$$\left.\begin{array}{r} I_1+I_2-I_3=0 \\ V_{AD}=18=2I_1+4I_3-(-5) \\ V_{CD}=15=4I_2+4I_3-(-5) \end{array}\right\} \Rightarrow I_1=2\,mA \quad I_2=0{,}25\,mA \quad I_3=2{,}25\,mA$$

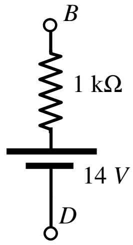
b) V_D=0. Therefore potential at point B is $V_B-V_D=V_B=4I_3-(-5)=4\cdot 2{,}25+5=14\,V$

c) Passive circuit and equivalent resistance between B and D (removing all the generators) is

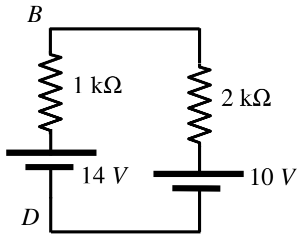


$$\frac{1}{R_{eq}}=\frac{1}{2}+\frac{1}{4}+\frac{1}{4}\Rightarrow R_{eq}=1\,k\Omega$$

So, Thevenin's equivalent generator between B and D is:



d) If the new branch is connected to the Thevenin's equivalent generator between points B and D, the resulting circuit is:



The intensity flowing along this circuit is: $I=\frac{\Sigma\varepsilon}{\Sigma R}=\frac{14-10}{1+2}=\frac{4}{3}=1,33\,mA$

in clockwise direction. Therefore, the 10 V battery is consuming the power: $P_{10V}=\varepsilon I=10\cdot 1,33=13,3\,mW$

3. (2,5 points) Let's consider a rectangular loop with sides **2*a*** and ***b***, flowed by an intensity of current ***I*** in the given direction. The loop is placed inside a no uniform magnetic field $\vec{B}=B_0\frac{a}{x}\vec{k}$.

Compute:

a) The magnetic force acting on sides **1** and **2**.

b) The magnetic moment of the loop.

c) If the magnetic field was $\vec{B}=B_0\vec{k}$ (B_0 a positive constant), compute the torque of the magnetic forces acting on the loop.

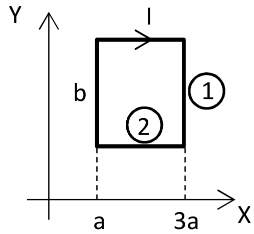
3. (2,5 puntos) Sea la espira rectangular de la figura de lados **2*a*** y ***b***, recorrida por una corriente de intensidad ***I*** en el sentido indicado, situada en el interior de un campo magnético no uniforme de valor $\vec{B}=B_0\frac{a}{x}\vec{k}$.

Calcula:

a) La fuerza magnética que aparece sobre los lados **1** y **2**.

b) El momento magnético de la espira.

c) Si el campo magnético fuera $\vec{B}=B_0\vec{k}$ (B_0 una constante positiva), calcula el momento de las fuerzas magnéticas que actúan sobre la espira.



a) Along side 1, magnetic field is constant, being $\vec{B}_1=B_0\frac{a}{3a}\vec{k}=\frac{B_0}{3}\vec{k}$

Taking in account the direction of intensity, the force acting on side 1 is: $\vec{F}_1=I\vec{L}_1\times\vec{B}_1=I(-b\vec{j}\times\frac{B_0}{3}\vec{k})=-\frac{IbB_0}{3}\vec{i}$

Along side 2, magnetic field isn't constant (it depends on x) and then the force must be integrated:

$$\vec{F}_2=\int_{Side2} Id\vec{x}\times\vec{B}=I\int_a^{3a}(-dx\vec{i})\times B_0\frac{a}{x}\vec{k}=IB_0a\int_a^{3a}\frac{dx}{x}\vec{j}=IB_0a\ln 3\vec{j}$$

b) As we only have a loop with area 2ab and the intensity is clockwise: $\vec{\mu}=I\vec{S}=I2ab(-\vec{k})=-2Iab\vec{k}$

c) As the magnetic field is parallel to yhe magnetic moment, $\vec{\tau}=\vec{\mu}\times\vec{B}=0$

4. (2,5 points) State **Ampère's law** and apply it to calculate the **magnetic field** created by an **infinite straight wire** flowed by an intensity of current **I**, at a distance **x** from the wire. **Justify the answer**.

4. (2,5 puntos) Enuncia el **teorema de Ampère** y aplícalo para determinar el **campo magnético** creado por un **hilo rectilíneo** de longitud infinita, por el que circula una intensidad **I**, a una distancia **x** del hilo. **Justifica la respuesta**.

Ampére's law statement appears on point 7.5 of notes:

"The circulation of magnetic field vector along any enclosed curve equals the product of the constant µ0 by the addition of the intensities of current crossing any surface bordered by the curve. The sign of the intensity will be positive when it was in accordance with the screw or the right hand rule with the sense of the circulation, and negative in another case."

$$C=\oint\vec{B}d\vec{l}=\mu_0\sum I$$

Related to the magnetic field created by a straight carrying current wire, on a point placed at a distance x, appears on next page:

In order to apply Ampère's law, we choose a circumference of radius *x*, perpendicular to conductor and centered on a point of such conductor. This circumference is a field line of magnetic field, being the magnetic field vector tangent to this line at any point. On the other hand, as distance to conductor is the same for all the points of line, modulus of magnetic field will also be the same. So, circulation of magnetic field along this circumference is $C = \oint \vec{B} d\vec{l} = B 2\pi x$

Considering the surface of a disk bordered by this circumference, the intensity crossing this disk is *I* (positive because its sense is in accordance with the sense of circulation chosen). Then, applying Ampère's law becomes

$$C = \oint \vec{B} d\vec{l} = B 2\pi x = \mu_0 I \Rightarrow B = \frac{\mu_0 I}{2\pi x}$$

Si te examinas sólo de una parte, debes resolver los cuatro problemas de esa parte.
If you are sitting only one part of the exam, then you have to solve the four problems of that part.

Si te examinas de dos partes, debes resolver los tres primeros problemas de ambas partes.
If you are sitting two parts of the exam, then you have to solve the three first problems of both parts.

Si te examinas de las tres partes, debes resolver los dos primeros problemas de cada una de las partes.
If you are sitting the three parts of the exam, then you have to solve the two first problems of every part.

FORM – FÓRMULAS

Direct current $V_A - V_B = I\sum R - \sum \varepsilon$ $I = \frac{\sum \varepsilon}{\sum R}$ $P = V \cdot I$ $\varepsilon = \frac{dW}{dq}$ $P_R = I^2 \cdot R$ $P_g = \varepsilon \cdot I$

$P_t = \varepsilon' \cdot I$ $P_g - P_r = P_s$ $P_t + P_{r'} = P_c$ $\eta_g = \frac{P_s}{P_g}$ $\eta_r = \frac{P_t}{P_c}$

Magnetic Forces $\vec{F} = q(\vec{v} \times \vec{B})$ $d\vec{F} = I d\vec{l} \times \vec{B}$ $\vec{\mu} = N \cdot I \cdot \vec{S}$ $\vec{\tau} = \vec{\mu} \times \vec{B}$ $V_H = \frac{I \cdot B \cdot d}{n \cdot e \cdot S}$

Sources of magnetic field $d\vec{B} = \frac{\mu_0 I}{4\pi} \frac{d\vec{\ell} \times \vec{r}}{r^3}$ $\mu_0 = 4\pi 10^{-7} (I.S.units)$ $B = \frac{\mu_0 I}{2\pi x}$

$B = \frac{\mu_0 I}{2R}$ $\oint_L \vec{B} \cdot d\vec{l} = \mu_0 \sum I$ $B = \frac{\mu_0 N I}{l}$