UNIVERSIDAD POLITECNICA DE VALENCIA	Retaking Second exam FFI Recuperación 2º parcial FFI **January 25th 2019** Year-Curso 2018/19	Applied Physics Dept. Dep. de Física Aplicada

1. (2,5 points) In the circuit on picture, compute:

a) **Intensity of current** flowing along the circuit. Give its **magnitude and direction**.

b) **Generated power** by those devices really generating power.

c) **Turned power** by the motor into mechanical energy, and its **efficiency**.

d) Difference of potential between points B and A (**V_{BA}**).

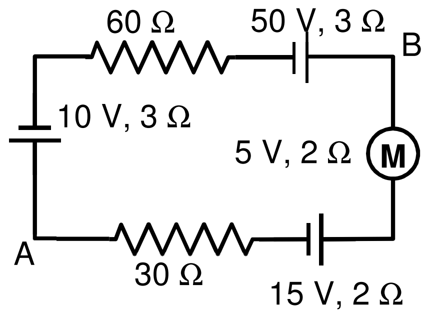
1. (2,5 puntos) En el circuito de la figura, calcula:

a) La **intensidad** de corriente que recorre el circuito. Indica su **valor** y su **sentido**.

b) La **potencia generada** por aquellos elementos que realmente la generan.

c) La **potencia transformada** en energía mecánica por el motor, y su rendimiento.

d) Diferencia de potencial entre los puntos B y A (**V_{BA}**).



Solution:

a) Because of the polarities of the batteries, we'll suppose that the current is flowing clockwise. So, the upper terminal of the motor will be the positive terminal and the lower terminal, the negative one. Therefore:

$$I=\frac{50-5-15-10}{60+3+2+2+30+3}=\frac{20}{100}=\frac{1}{5}=0,2\ A$$

b) Only the 50 V battery is generating power. The generated power is:

$$P_g=50\cdot 0,2=10\ w$$

c) $P_t=5\cdot 0,2=1\ w$ $\qquad P_c=1+0,2^2\cdot 2=1,08\ w$ $\qquad \eta=\frac{1}{1,08}=0,926\Rightarrow 93\%$

d) $V_{BA}=0,2(2+2+30)-(-5-15)=26,8\ V$

2. (2,5 points) Given the circuit on picture

a) Find the intensities **I_1**, **I_2**, e **I_3** by using Kirchoff's rules.

b) Compute the **Thevenin's equivalent generator** between points **A** and **B**, clearly showing its **polarity**.

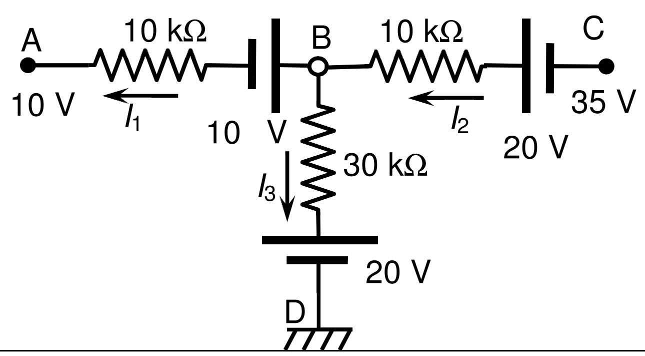
c) If the branch on right is **connected** between points **B** and **A**, say if the battery of **10 V** in the new branch is consuming or generating power, computing this power.

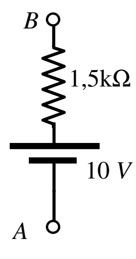
2. (2,5 puntos) Dado el circuito de la figura

a) Determina las intensidades de rama **I_1**, **I_2**, e **I_3** mediante las leyes de Kirchhoff.

b) Calcula el **generador equivalente de Thevenin** entre los puntos **A** y **B**, indicando claramente su **polaridad**.

c) Si se **conecta** la rama de la derecha entre los puntos **B** *y* **A**, indica si la batería de **10 V** consume o genera potencia y calcula su valor.



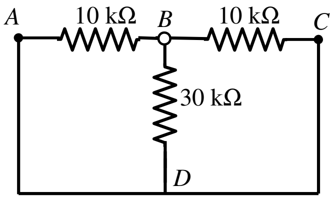


a) This is a network with 2 junctions and two loops, and so we'll need one equation for junctions and two equations for loops:

$$\left.\begin{array}{c} -I_1+I_2-I_3=0 \\ V_{AD}=10=-10I_1-(10)+30I_3-(-20) \\ V_{CD}=35=10I_2-(20)+30I_3-(-20) \end{array}\right\}\Rightarrow I_1=\frac{3}{2}=1,5\ mA \quad I_2=2\ mA \quad I_3=\frac{1}{2}=0,5\ mA$$

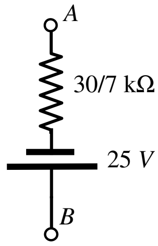
b) $V_A - V_B = V_B = -10I_1 - (10) = -15 - 10 = -25\,V$

Passive circuit and equivalent resistance between A and B (after remove every generator) is

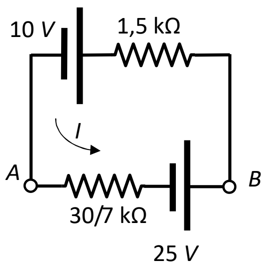


$$\frac{1}{R_{AB}} = \frac{1}{10} + \frac{1}{10} + \frac{1}{30} \Rightarrow R_{AB} = \frac{30}{7}\,k\Omega$$

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



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



The intensity flowing along this circuit is: $I = \frac{\Sigma\varepsilon}{\Sigma R} = \frac{25-10}{\frac{30}{7}+1,5} = 2,6\,mA$

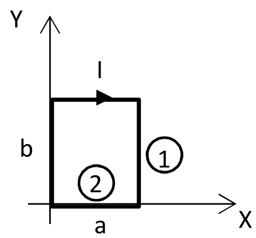
in counterclockwise direction. Therefore, the 10 V battery is consuming the power: $P_{10V} = \varepsilon I = 10 \cdot 2,6 = 26\,mW$

3. (2,5 points) Let's consider a rectangular loop with sides ***a*** and ***b***, flowed by an intensity of current ***I*** in the given direction. The loop is placed inside a uniform and stationary magnetic field $\vec{B} = 2B_0\vec{i} + B_0\vec{j}$. Compute, in vector form:

a) The magnetic **force** acting on **right side** (**1**) and **lower side** (**2**) of the loop.
b) The **total force** acting on the loop.
c) The **magnetic moment** of the loop.
d) The **torque** of the magnetic forces acting on the loop.

3. (2,5 puntos) Sea la espira rectangular de la figura de lados ***a*** y ***b***, recorrida por una corriente de intensidad ***I*** en el sentido indicado. La espira está situada en el interior de un campo magnético uniforme y estacionario, de valor $\vec{B} = 2B_0\vec{i} + B_0\vec{j}$. Calcula, vectorialmente:

a) La **fuerza** magnética que actúa sobre el lado derecho **(1)** y el inferior (**2**) de la espira.
b) La **fuerza total** que actúa sobre la espira.
c) El **momento magnético** de la espira.
d) El **momento** de las fuerzas magnéticas que actúa sobre la espira.



a) By taking in account the direction of intensity, the forces acting on sides 1 and 2 are:

$$\vec{F}_1 = I\vec{L}_1 \times \vec{B}_1 = I(-b\vec{j}) \times (2B_0\vec{i} + B_0\vec{j}) = 2IbB_0\vec{k} \qquad \vec{F}_2 = I\vec{L}_2 \times \vec{B} = I(-a\vec{i}) \times (2B_0\vec{i} + B_0\vec{j}) = -IaB_0\vec{k}$$

b) The total force acting on the loop is null because the magnetic field is uniform. The force acting on a closed loop under a uniform magnetic field is always zero.

c) As the area of the loop is ab and the intensity is clockwise: $\vec{\mu} = I\vec{S} = Iab(-\vec{k}) = -Iab\vec{k}$

c) The torque acting on the loop is

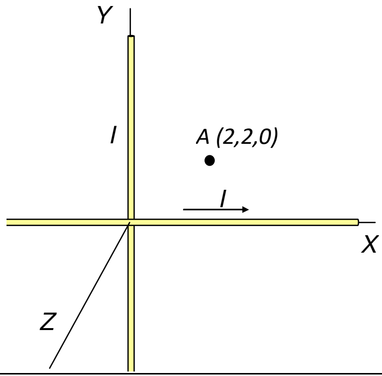
$$\vec{\tau} = \vec{\mu} \times \vec{B} = (-Iab\vec{k})x(2B_0\vec{i} + B_0\vec{j}) = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & -Iab \\ 2B_0 & B_0 & 0 \end{vmatrix} = IabB_0\vec{i} - 2IabB_0\vec{j} = IabB_0(\vec{i} - 2\vec{j})$$

4. (2,5 points) Two **infinite** straight carrying current **conductors** are placed on **plane XY**, overlapped to axes X and Y, as can be seen on picture. Both conductors carry **equal intensities**, **I**, and that of **horizontal axis** is flowing **to right**. The modulus of the magnetic field at point **A (2,2,0) m** is **B_A=10^{-5} T**. Find:

a) The direction of the current flowing along vertical conductor (upwards or downwards) and the direction of the magnetic field at point A ($+\vec{k}$ o $-\vec{k}$). **Justify the answer.**
b) The magnitude of I.
c) The magnetic field vector at point B(-1,2,0) m.
d) Give the coordinates of some point where the magnetic field was null.

4. (2,5 puntos) Dos **conductores** rectilíneos e **indefinidos** se encuentran en el **plano XY**, sobre los ejes X e Y, como puede verse en la figura. Los dos conductores llevan **intensidades iguales**, **I**, circulando la del **eje horizontal** hacia la **derecha**. El modulo del campo magnético en el punto **A (2,2,0) m** es **B_A=10^{-5} T**. Halla:

a) La dirección de la corriente que circula por el conductor vertical (hacia arriba o hacia abajo), y la dirección del campo magnético en el punto A ($+\vec{k}$ o $-\vec{k}$). **Justifica la respuesta.**
b) El valor de I.
c) El vector campo magnético en el punto B(-1,2,0) m.
d) Da las coordenadas de algún punto donde se anule el campo magnético.



On every case, the magnetic field is the summatory of magnetic field produced by each conductor:

a) The magnetic field created at point A by the horizontal conductor is exiting from the paper, according the right hand rule. If the current along the vertical conductor would flow upwards, its magnetic field at A would be entering on the paper. As the currents are equal and the distances are also equal (2 m), the total magnetic field would be null. Therefore, the intensity along the vertical conductor must flow downwards.

   Then, the magnetic field due to both conductors at A is exiting from the paper, direction $+\vec{k}$.

b) $B_A = 2\frac{\mu_0 I}{2\pi \cdot 2} = 10^{-5} \Rightarrow I = \frac{2\pi \cdot 10^{-5}}{\mu_0} = \frac{2\pi \cdot 10^{-5}}{4\pi \cdot 10^{-7}} = \frac{1}{2}10^2 = 50\ A$

c) $\vec{B}_B = \vec{B}_x + \vec{B}_y = \frac{\mu_0 I}{2\pi \cdot 2}\vec{k} - \frac{\mu_0 I}{2\pi \cdot 1}\vec{k} = -\frac{\mu_0 I}{2\pi \cdot 2}\vec{k} = -0{,}5 \cdot 10^{-5}\vec{k}\ T$

d) The magnetic field can only be null where both magnetic fields are opposite, it is, at second and fourth quadrant. Moreover, as the intensities are equal, the distance to the conductors must be equal. Therefore, the magnetic field will be null at points (-x,x) and (x,-x). For example, point (3,-3,0) is a point where the magnetic field is null.

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

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