UNIVERSIDAD POLITECNICA DE VALENCIA

Retaking Second exam FFI
Recuperación 2º parcial FFI
January 24th 2020
Year-Curso 2019/20

Applied Physics Dept.
Dep. de Física Aplicada

5. (2,5 points) Two measurements of the **difference of potential** and the i**ntensity** of current flowing along a **linear generator** have been carried out, being the results those shown on the **table**. Find

a) Its **electromotive force** and **internal resistance.**

The **dipole AB** on picture is connected to this generator, making up a circuit. Find:

b) **Current** flowing.

c) **Generated power and turned power.**

d) Difference of **potential** between A and B.

e) **Efficiency** of generator and motor.

5. (2,5 puntos) Se han realizado **dos mediciones** de la diferencia de **potencial** y la **intensidad** que circula por un **generador lineal**, obteniendo los resultados de la **tabla** mostrada:

a) ¿Cuál es su **fuerza electromotriz** y su **resistencia interna**?

A este generador se le conecta el **dipolo AB** de la figura formando así un circuito. Determina:

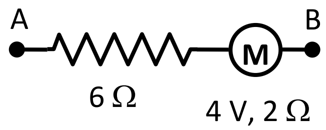
b) **Corriente** que circula.

c) **Potencia generada y potencia transformada.**

d) Diferencia de **potencial** entre A y B.

e) **Rendimiento** del generador y del motor.

	V_{AB} (V)	I_{AB} (A)
Measurement 1	5	0,1
Measurement 2	2	0,4



Solution:

a) The difference of potential on terminals A and B of a linear generator comes from $V_{AB} = \varepsilon - Ir$

From the two measurements, it comes:

$5 = \varepsilon - 0,1 \cdot r$ and $2 = \varepsilon - 0,4 \cdot r$

By solving this system, we find: $\varepsilon = 6\,V$ and $r = 10\,\Omega$

b) If we connect the dipole on picture, the intensity flowing along this circuit is: $I = \dfrac{6-4}{10+6+2} = \dfrac{1}{9} = 0,11\,A$

c) $P_g = \varepsilon I = 6 \cdot \dfrac{1}{9} = 0,66\,w$ $\quad P_t = \varepsilon' I = \dfrac{4}{9} = 0,44\,w$

d) $V_{AB} = \varepsilon - Ir = 6 - \dfrac{1}{9} \cdot 10 = \dfrac{44}{9} = 4,89\,V$

e) Generator: $P_S = V_{AB} I = 4,89 \cdot 0,11 = 0,54\,w$ $\quad \eta = \dfrac{P_s}{P_g} = \dfrac{0,54}{0,66} \approx 0,81 \Rightarrow \eta \text{ is near } 81\%$

Receptor: $P_C = P_t + P_{r'} = P_t + I^2 r' = 0,44 + 0,11^2 \cdot 2 = 0,46\,w$ $\quad \eta = \dfrac{P_t}{P_C} = \dfrac{0,44}{0,46} \approx 0,96 \Rightarrow \eta \text{ is near } 96\%$

6. (2,5 points) Given the circuit on picture

a) Find the intensities $\mathbf{I_1}$, $\mathbf{I_2}$, e $\mathbf{I_3}$ by taking in account that the branch **BD** is an **open circuit**.

b) Total **power generated** on circuit.

c) Compute the **Thevenin's equivalent generator** between **C** and **ground**, clearly showing its **polarity**.

d) If the branch on right is **connected** between points **C** and **ground**, compute the **intensity** flowing along the 4 V receptor, and its **turned power**.

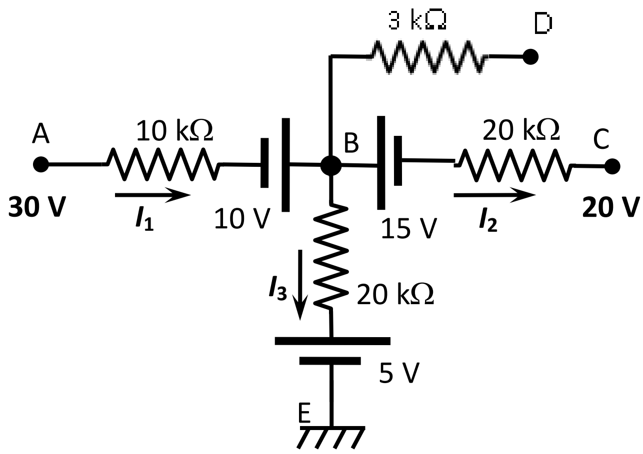
6. (2,5 puntos) Dado el circuito de la figura

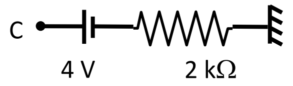
a) Determina las **intensidades** de rama $\mathbf{I_1}$, $\mathbf{I_2}$, e $\mathbf{I_3}$, teniendo en cuenta que la rama **BD** está en **circuito abierto**.

b) **Potencia** total **generada** en el circuito.

c) Calcula el **generador equivalente de Thevenin** entre **C** y **tierra**, indicando claramente su **polaridad**.

d) Si se **conecta** la rama de la derecha entre los puntos **C** *y* **tierra**, calcula la **intensidad** que circula por el receptor de 4 V, y su **potencia transformada**.





Solution:

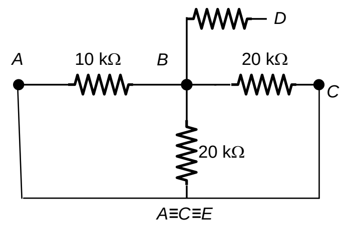
The branch BD is an open circuit, and then its intensity of current is null (I_{BD}=0) , reason why the point D will have the same potential than point B. Therefore, this circuit is a network with 2 junctions and two loops, and so we'll need one equation for junctions and two equations for loops:

a)
$$\left.\begin{aligned} I_1 &= I_2 + I_3 \\ V_{AE} &= 30 = 10I_1 - 10 + 20I_3 + 5 \\ V_{CE} &= 20 = -20I_2 - 15 + 20I_3 + 5 \end{aligned}\right\} \Rightarrow I_1 = 1\,mA \quad I_2 = -\frac{1}{4} = -0,25\,mA \quad I_3 = \frac{5}{4} = 1,25\,mA$$

b) The only generator consuming power is that placed on branch BE. The total generated power by the other generators is: $P_g = 10 \cdot I_1 + 15 \cdot (-I_2) = 10 + 3,75 = 13,75\,mW$

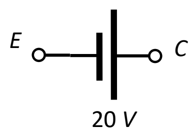
c) $\varepsilon_T = V_{CE} = 20\,V$

Passive circuit after removing all the generators is



and its equivalent resistance between C and E is null: $R_{CE} = 0$

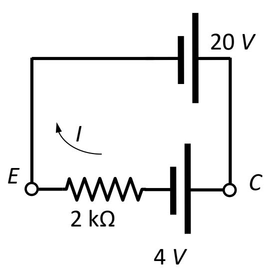
So, Thevenin's equivalent generator between C and E is:



d) If we connect the new branch between points C and E, the resulting circuit is that on picture. The intensity flowing in clockwise direction is:

$$I = \frac{20-4}{2} = 8\,mA$$

And the turned power $P_t = \varepsilon' I = 4 \cdot 8 = 32\,mW$



7. (2,5 points) Two **parallel** and **infinite** conductors with currents ***I*** and **2*I*** in the same direction are placed at a distance ***a*** as can be seen on picture. Given the reference system, compute:

a) **Magnetic field** $\vec{B}_1$ produced by conductor 2 at point **1** (0,0,0) and **magnetic field** produced by conductor 1 at point **2** (*a*,0,0) $\vec{B}_2$.

b) **Force** acting on a stretch of length **L** of conductor 1, $\vec{F}_1$,

7. (2,5 puntos) Dos conductores **paralelos** e **indefinidos** por los que circulan dos corrientes del mismo sentido ***I*** y **2*I*** están separados una distancia ***a*** tal como muestra la figura. Dado el sistema de referencia de la figura, calcula:

a) **Campo magnético** $\vec{B}_1$ producido por el conductor 2 en el punto **1** (0,0,0) y **campo magnético** producido por el conductor 1 en el punto **2** (*a*,0,0) $\vec{B}_2$.

b) **Fuerza** sobre un tramo de longitud **L** del conductor 1, and **force** acting on a stretch of length **L** of conductor 2, $\vec{F}_2$. ¿Both conductors are **attracted** or **rejected**?

c) **Magnetic field** at the midpoint P(a/2,0,0)

d) **Magnetic field** at point Q(0,a,0).

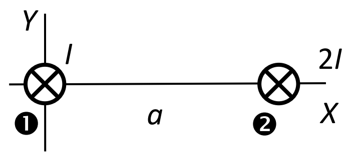
e) Find a **point** on the joining line where the **magnetic field** was **null**.

$\vec{F}_1$ y **fuerza** sobre un tramo de longitud **L** del conductor 2, $\vec{F}_2$. ¿Los conductores se **atraen** o se **repelen**?

c) **Campo magnético** en el punto medio P(a/2,0,0)

d) **Campo magnético** en el punto Q(0,a,0).

e) ¿En qué **punto** de la línea de unión es **nulo el campo magnético**?



Solution:

a) $\vec{B}_1 = \frac{\mu_0 2I}{2\pi a}\vec{j} \qquad \vec{B}_2 = -\frac{\mu_0 I}{2\pi a}\vec{j}$

b) $\vec{F}_1 = I(-L\vec{k})\times\frac{\mu_0 I}{\pi a}\vec{j} = \frac{\mu_0 I^2 L}{\pi a}\vec{i} \qquad \vec{F}_1 = 2I(-L\vec{k})\times(-\frac{\mu_0 I}{2\pi a}\vec{j}) = -\frac{\mu_0 I^2 L}{\pi a}\vec{i}$

The force between both conductors is attractive.

c) $\vec{B}_P = -\frac{\mu_0 I}{2\pi\frac{a}{2}}\vec{j} + \frac{\mu_0 2I}{2\pi\frac{a}{2}}\vec{j} = \frac{\mu_0 I}{\pi a}\vec{j}$

d) $\vec{B}_Q = \frac{\mu_0 I}{2\pi a}\vec{i} + \frac{\mu_0 2I}{2\pi a\sqrt{2}}(\frac{\vec{i}+\vec{j}}{\sqrt{2}}) = \frac{\mu_0 I}{2\pi a}(2\vec{i}+\vec{j})$

e) If the coordinates of such points are (x,0,0) then must be verified:

$\frac{\mu_0 I}{2\pi x} = \frac{\mu_0 2I}{2\pi(a-x)} \Rightarrow a - x = 2x \Rightarrow x = \frac{1}{3}a$ Such point is (a/3,0,0)

8. (2,5 points) A coil is made up by a set of **100 windings, 8 cm** length and **6 cm** height. It is placed on plane **ZY**, and flowed by a current **5 A** in the shown direction. A magnetic field $\vec{B} = \vec{i} + 3\vec{j} - 2\vec{k}$ T is acting over the coil. Compute:

a) **Magnetic moment** of coil.

b) **Torque** of magnetic forces acting on coil.

c) M**agnetic force** acting on side lying on Z axis.

d) **Total magnetic force** acting on coil.

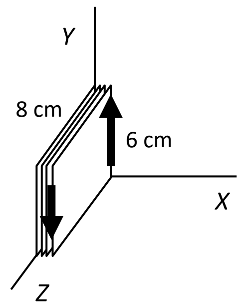
8. (2,5 puntos) Una bobina de **100 espiras** de **8 cm** de largo por **6 cm** de ancho está situada en el plano **ZY**, tal como muestra la figura. Por ella circula una corriente de **5 A** en el sentido indicado, y está situada en un campo magnético $\vec{B} = \vec{i} + 3\vec{j} - 2\vec{k}$ T. Calcula:

a) **Momento magnético** de la bobina.

b) **Momento de las fuerzas** magnéticas que actúan sobre la bobina.

c) **Fuerza magnética** sobre el lado coincidente con el eje Z.

d) **Fuerza magnética** neta sobre la bobina.



Solution:

a) $\vec{\mu} = NI\vec{S} = 100\cdot 5\cdot 48\cdot 10^{-4}\vec{i} = 2{,}4\vec{i}\ Am^2$

b) $\vec{\tau} = \vec{\mu}\times\vec{B} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 2{,}4 & 0 & 0 \\ 1 & 3 & -2 \end{vmatrix} = 4{,}8\vec{j} + 7{,}2\vec{k}\ Nm$

c) $\vec{F}_z = NI\vec{L}\times\vec{B} = 100\cdot 5\cdot(-8\cdot 10^{-2}\vec{k})\times(\vec{i}+3\vec{j}-2\vec{k}) = 500\begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & -8 \\ 1 & 3 & -2 \end{vmatrix}\cdot 10^{-2} = 40(3\vec{i}-\vec{j})\,N$

d) As the magnetic field acting on the loop is a uniform magnetic field, the total force acting on loop 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: *1 and 2: 1,2,3,5,6,7* *1 and 3: 1,2,3,9,11,12* *2 and 3: 5,6,7,9,11,12*
If you are sitting two parts of the exam: 1 and 2: 1,2,3,5,6,7 1 and 3: 1,2,3,9,11,12 2 and 3: 5,6,7,9,11,12

Si te examinas de las tres partes, debes resolver: *1,3,6,7,9,11*
If you are sitting the three parts of the exam, then you have to solve: 1,3,6,7,9,11

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

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

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) $B = \frac{\mu_0 I}{2\pi x}$

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