UNIVERSIDAD POLITECNICA DE VALENCIA

Retaking Third exam FFI
January 25th 2016
Year 2015/16

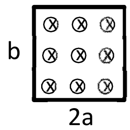
Applied Physics Dept.

1. (2,5 puntos) Sobre la espira rectangular de la figura, de lados ***2a*** y ***b***, y resistencia **R**, actúa un campo magnético uniforme **B = 2sen(5t) T** perpendicular a la espira. Calcular, en un instante t>0:

a) El flujo magnético ϕ que atraviesa la espira.
b) Fuerza electromotriz ε inducida en la espira.
c) Intensidad de corriente i que circula por la espira.
d) El módulo de la fuerza que actúa sobre uno de los lados de longitud **b**.

1. (2,5 points) Over the rectangular loop on picture (sides ***2a*** and ***b*** and resistance **R**) acts a uniform magnetic field **B = 2sen(5t) T** perpendicular to the loop. Calculate on a time t>0:

a) The magnetic flux ϕ through the loop.
b) The electromotive force ε induced on loop.
c) Intensity of current i flowing along the loop.
d) The modulus of force acting on one of sides of loop with length **b**.



a) Magnetic field is uniform and then the magnetic flux is: $\phi = \int_{loop} \vec{B}\cdot d\vec{S} = \vec{B}\cdot\vec{S} = BS = 2sen(5t)\cdot 2ab = 4ab\cdot sen(5t)$

b) $|\varepsilon| = \frac{d\phi}{dt} = 4ab\cdot 5\cdot cos(5t) = 20ab\cdot cos(5t)$

c) $i = \frac{\varepsilon}{R} = \frac{20ab\cdot cos(5t)}{R}$ This intensity is changing its direction according the changes on magnetic field (sinusoidal magnetic field), not having always the same direction.

d) The magnetic field is uniform and perpendicular to side. Then the modulus of force acting on a vertical side of loop on a time t is:

$$F = iLB = \frac{20ab\cdot cos(5t)}{R} b2sen(5t) = \frac{40ab^2}{R} sen(5t)cos(5t)$$

2. (2,5 puntos) Una autoinducción de ***40 mH*** y una resistencia de ***3 Ω*** están conectadas en serie (dipolo RL). Por el dipolo circula una corriente senoidal ***i(t)=5cos(100t-10°) A***. Calcular:

a) La tensión instantánea en la resistencia $u_R(t)$.
b) La tensión instantánea en la autoinducción $u_L(t)$.
c) La impedancia Z y el ángulo de desfase φ del dipolo. Dibuja el triángulo de impedancias.
d) La tensión instantánea u(t) entre los terminales del dipolo.

2. (2,5 points) A ***40 mH*** sized inductor and a resistor ***3 Ω*** sized are connected in series (dipole RL). Along the dipole is flowing a sinusoidal current ***i(t)=5cos(100t-10º) A***. Compute:

a) Instantaneous voltage on resistor $u_R(t)$.
b) Instantaneous voltage on inductor $u_L(t)$.
c) Impedance Z and phase lag φ of dipole.
d) The instantaneous voltage u(t) between terminals of dipole.

a) On a resistor, phase lag between voltage and intensity is zero. So,
$u_R(t) = 3\cdot 5cos(100t - 10º) = 15cos(100t - 10º)V$

b) $X_L = L\omega = 40\cdot 10^{-3}\cdot 100 = 4\ \Omega$

Phase lag on an inductor is π/2 (90º) : $\varphi = 90º = \varphi_u - \varphi_i = \varphi_u - (-10) \Rightarrow \varphi_u = 90 - 10 = 80º$

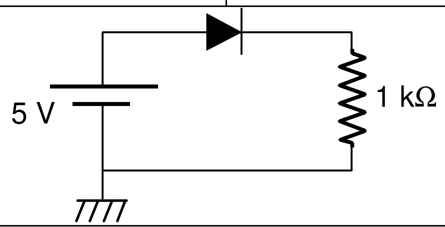
Therefore $u_L(t) = 4\cdot 5cos(100t + 80º) = 20cos(100t + 80º)V$

c) $Z = \sqrt{R^2 + (L\omega - 1/C\omega)^2} = \sqrt{3^2 + 4^2} = 5\ \Omega$ $\qquad tg\varphi = \frac{L\omega}{R} = \frac{4}{3} = 1,33 \Rightarrow \varphi = 53,1º = 0,93\ rad$

d) $U_m = I_m Z = 5\cdot 5 = 25V$ $\qquad \varphi = 53,1º = \varphi_u - \varphi_i = \varphi_u - (-10) \Rightarrow \varphi_u = 53,1 - 10 = 43,1º$

So, instantaneous voltage on dipole is: $u(t) = 25cos(100t + 43,1º)V$

3. (2,5 puntos) Calcula la corriente que circula por el circuito de la figura, utilizando las tres aproximaciones para el diodo: a) Primera aproximación. Diodo ideal. b) Segunda aproximación. c) Tercera aproximación. La tensión umbral del diodo es de 0,7 V, y su resistencia interna 4Ω.	**3.** (2,5 puntos) Get the current flowing along the circuit on picture, by using the three approaching for a diode: a) First approaching. Ideal diode. b) Second approaching. c) Third approaching. Drop forward voltage of diode is 0,7 V, and its internal resistance 4Ω.



a) According first approaching of diode, it behaves as a switch, without consider neither the drop forward voltage nor the internal resistance. As diode on circuit is forward biased: $i_1 = \frac{\varepsilon}{R} = \frac{5}{1} = 5\,mA$

b) The second approaching takes in account the drop forward voltage (0,7 V). Therefore: $i_2 = \frac{\varepsilon - V_u}{R} = \frac{5-0,7}{1} = 4,3\,mA$

c) Third approaching considers the drop forward voltage and the internal resistance of diode: $i_3 = \frac{\varepsilon - V_u}{R+r} = \frac{5-0,7}{1+0,004} \approx 4,3\,mA$

4. (2,5 puntos) Halla la expresión del coeficiente de autoinducción de un solenoide de sección circular de radio ***R***, longitud ***d*** y ***N*** espiras, admitiendo que el campo magnético en su interior es **uniforme**.	**4**. (2,5 points) Get the equation of self-inductance of an inductor with radius **R**, length **d** and **N** turns, by assuming a **uniform** magnetic field inside the inductor.

The self inductance coefficient of an inductor is defined as the rate between the flux through the inductor and the intensity flowing along the inductor. If we consider the inductor flowed by a current I, the magnetic field inside the inductor is: $B = \frac{\mu_0 N I}{d}$. This magnetic flux can be taken as uniform.

The magnetic flux through the inductor is: $\phi = NBS = N\frac{\mu_0 N I}{d}\pi R^2 = \frac{\mu_0 N^2 I \pi R^2}{d}$

And the self inductance coefficient: $L = \frac{\phi}{I} = \frac{\mu_0 N^2 \pi R^2}{d}$

FORM

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

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

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

Electromagnetic induction $|\varepsilon| = \frac{d\phi}{dt}$ $\phi = L \cdot I$ $\phi_{21} = M \cdot I_1$ $\varepsilon = L\frac{di}{dt}$

$W_L = \frac{1}{2} L \cdot I^2$

Alternating current $\varphi = \varphi_u - \varphi_i$ $X_L = L\omega$ $X_C = \frac{1}{C\omega}$ $U_{rms} = \frac{U_m}{\sqrt{2}}$ $I_{rms} = \frac{I_m}{\sqrt{2}}$

$tg\,\varphi = \frac{L\omega - 1/C\omega}{R}$ $Z = \frac{U_m}{I_m} = \sqrt{R^2 + (L\omega - 1/c\omega)^2}$

$P(t) = u(t) \cdot i(t) = U_m I_m \cos\varphi \sin^2 \omega t + \frac{U_m I_m}{2} \sin\varphi \sin\omega t$ $P_{av} = \frac{U_m I_m}{2} \cos\varphi$ $f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}$

Semiconductors $n \cdot p = n_i^2$ $N_A + n = N_D + p$

1. Si te examinas de un único parcial: Debes resolver los cuatro ejercicios de ese parcial.
2. Si te examinas de dos parciales: Debes resolver los ejercicios 1, 2 y 3 de cada uno de los dos parciales (en total 6 ejercicios). Los 6 ejercicios puntúan igual.
3. Si te examinas de los tres parciales: Debes resolver los ejercicios 1 y 2 de cada uno de los tres parciales (en total 6 ejercicios). Los 6 ejercicios puntúan igual.

1. If you are sitting only one midterm exam: You must solve the four exercises of this midterm exam.
2. If you are sitting two midterm exams: You must solve exercises 1, 2 and 3 of both midterm exams. (6 exercises as a whole). Every exercises weight equal.
3. If you are sitting three midterm exams: You must solve exercises 1 and 2 of three midterm exams, (6 exercises as a whole). Every exercises weight equal.