PHYS 102: General Physics 2  
KOÇ UNIVERSITY  
College of Sciences  
Fall Semestre 2015  
Section 3  
Quiz 10  
04 December 2015

Closed book. No calculators are to be used for this quiz.  
Quiz duration: 10 minutes

Name:  
Student ID:  
Signature:

Suppose the loop in the figure below is  
\(a\) rotated about the y-axis;  
\(b\) rotated about the x-axis;  
\(c\) rotated about an edge parallel to the z-axis.

What is the maximum induced emf in each case if \(A = 600 \text{ cm}^2\), \(\omega = 35.0 \text{ rad/s}\),  
\(B = 0.450 T\)?

\[\varepsilon = - \frac{d \Phi_B}{dt} = - \frac{d}{dt} \left( (B \cdot \hat{x}) \cdot (A \hat{n}) \right) = - \frac{d}{dt} (BA \cos \omega t) = \]

\[= BA \omega \sin \omega t\]

\[\Rightarrow \varepsilon_{\text{max}} = BA \omega = (0.45 T) \cdot (600 \cdot 10^{-4} \text{ m}^2) \cdot (35 \text{ rad/s}) = \]

\[= 0.945 \text{ T m}^2/\text{s} \]

\[b) \quad \varepsilon = - \frac{d}{dt} \left( (B \cdot \hat{x}) \cdot (A \hat{n}) \right) = - \frac{d}{dt} (BA \cos 0^\circ) = 0 \]

\[c) \quad \text{Let the loop to rotate about the right (R) edge parallel to the z-axis. This case is the same as in a)} \]

\[\varepsilon = - \frac{d}{dt} \left( (B \cdot \hat{x}) \cdot (A \hat{n}) \right) = - \frac{d}{dt} (BA \cos \omega t) = \]

\[= BA \omega \sin \omega t\]

\[\varepsilon_{\text{max}} = BA \omega = 0.945 \text{ T m}^2/\text{s} \]
A rectangle measuring 30.0 cm by 40.0 cm is located inside a region of a spatially uniform magnetic field of 1.25 T, with the field perpendicular to the plane of the coil as shown in the figure. The coil is pulled out at a steady rate of 2.00 cm/s traveling perpendicular to the field lines. The region of the field ends abruptly as shown. Find the induced emf induced in this coil when it is:

a) All inside the field;

b) Partly inside the field;

c) All outside the field.

\[ \varepsilon = - \frac{d}{dt} (B \cdot A) = - \frac{d}{dt} (BA) = 0 \]

where \( B = \text{const.} = 1.25 \text{T} \) and \( A = 0.3 \text{m} \cdot 0.4 \text{m} = 0.12 \text{ m}^2 = \text{const.} \)

b) Let

\[ A = 0.4 \cdot (0.3 - x) \]

\[ B = \text{const} = 1.25 \text{T} \]

\[ \varepsilon = - \frac{d}{dt} (BA) = - B \cdot \frac{dA}{dt} = - B \frac{d}{dt} (0.4 \cdot (0.3 - x)) = 0.4 B \cdot \frac{dx}{dt} = 0.4 B v = 0.4 \cdot 1.25 \cdot 0.02 = 0.01 \text{ Tm}^2/\text{s} \]

c) The same as in b) for \( x = 0.3 \text{ m} \) \( \Rightarrow \varepsilon = 0.01 \text{ Tm}^2/\text{s} \)
The current in the long, straight wire AB shown in the figure below is upward and is increasing steadily at a rate $\frac{di}{dt}$.

\(\psi\) At an instant when the current is \(i\), what are the magnitude and direction of the field \(\vec{B}\) at a distance \(r\) to the right of the wire?

\(\psi\) What is the flux \(\Phi_B\) through the narrow, shaded strip?

\(\psi\) What is the total flux through the loop?

\(\psi\) What is the induced emf in the loop?

\[ a) \text{ From Ampère's law:} \quad \oint_{C} \vec{B} \cdot d\vec{L} = \mu_0 I_{enc} \]

where \(I_{enc} = i(t) = \frac{di}{dt} \) and \(\frac{di}{dt} = \text{const.} \)

\(\Rightarrow\) \(B \cdot (2\pi r) = \mu_0 i \Rightarrow B = \frac{\mu_0 i}{2\pi r} \)

The direction of \(\vec{B}\) into into the plane \(\otimes\) at \(\Gamma\).

b) \(d \Phi_B = \vec{B} \cdot d\vec{S} = B \cdot (L \, dr) = \frac{\mu_0 i L}{2\pi r} (\vec{B} \parallel \vec{S}) \)

c) \(\Phi_B = \int_{b}^{a} \vec{B} \cdot d\vec{S} = \frac{\mu_0 i L}{2\pi} \int_{r}^{a} \frac{dr}{r} = \frac{\mu_0 i L}{2\pi} \ln \left(\frac{b}{a}\right) \)

d) \(E = -\frac{d \Phi_B}{dt} = -\frac{\mu_0 L}{2\pi} \frac{di}{dt} \ln \left(\frac{b}{a}\right) \)