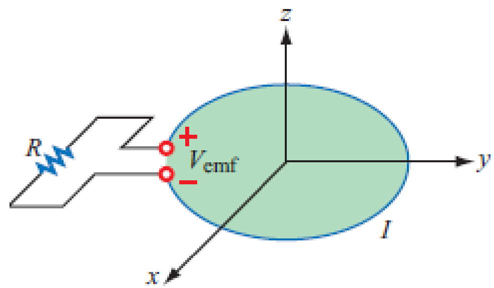
EE324 Quiz # 7 Spring 2013

Closed Book

Name (Last, First) ……………………………………………………………………………………………

The loop in the figure below is in the x-y plane and $\vec{B} = \hat{z}B_0 \sin \omega t$ with B_0 positive. What is the direction of I ($\hat{\phi}$ or $-\hat{\phi}$) at ωt= 0, π/4 and π/2.

$$V_{emf} = -\frac{\partial}{\partial t}\int_S \vec{B}\cdot d\vec{S} = -\frac{\partial \Phi}{\partial t}$$



Solution: $I = V_{emf}/R$. Since the single-turn loop is not moving or changing shape with time, $V_{emf}^{m} = 0$ V and $V_{emf} = V_{emf}^{tr}$. Therefore, from Eq. (6.8),

$$I = V_{emf}^{tr}/R = \frac{-1}{R}\int_S \frac{\partial \mathbf{B}}{\partial t}\cdot d\mathbf{s}.$$

If we take the surface normal to be $+\hat{\mathbf{z}}$, then the right hand rule gives positive flowing current to be in the $+\hat{\boldsymbol{\phi}}$ direction.

$$I = \frac{-A}{R}\frac{\partial}{\partial t}B_0 \sin \omega t = \frac{-AB_0\omega}{R}\cos \omega t \quad \text{(A)},$$

where A is the area of the loop.

(a) A, ω and R are positive quantities. At $t = 0$, $\cos \omega t = 1$ so $I < 0$ and the current is flowing in the $-\hat{\boldsymbol{\phi}}$ direction (so as to produce an induced magnetic field that opposes B).

(b) At $\omega t = \pi/4$, $\cos \omega t = \sqrt{2}/2$ so $I < 0$ and the current is still flowing in the $-\hat{\boldsymbol{\phi}}$ direction.

(c) At $\omega t = \pi/2$, $\cos \omega t = 0$ so $I = 0$. There is no current flowing in either direction.