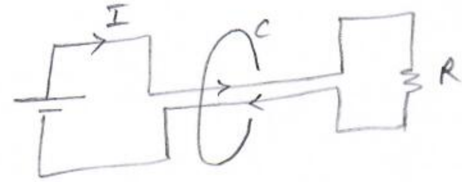
Solutions

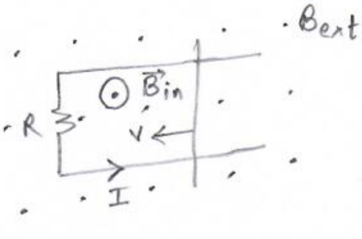
Midterm Exam 03 (PHYS-205B-001) Spring 2023

Prob. 1



$$\oint_C \vec{B}\cdot d\vec{l} = \mu_0 (I - I)$$
$$= 0$$

Prob. 2

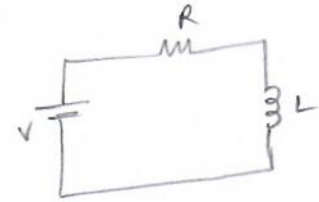


Flux is decreasing

$\vec{B}_{in}$ is along $\vec{B}_{ext}$

Current I is induced CCW

Prob. 3



In steady state I is constant.

$\Rightarrow \frac{dI}{dt} = 0 \quad \Rightarrow L\frac{dI}{dt} = 0$

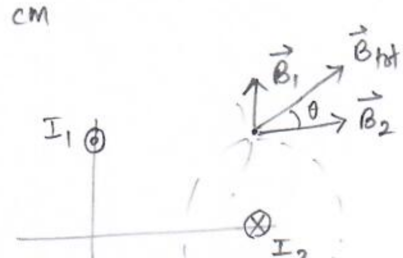
$\Rightarrow$ voltage drop across L is zero.

$\Rightarrow$ voltage drop across R is V.

Prob. 4

$$\lambda = \frac{c}{f} = \frac{3.00\times 10^{8}\ \text{m/s}}{2.45\times 10^{9}\ \text{1/s}} = 12.2\ \text{cm}$$

Prob. 5



$$\vec{B}_1 = 0\,\hat{i} + \hat{j}\,\frac{\mu_0 I_1}{2\pi x} = 0\,\hat{i} + \hat{j}\,2.5\,\mu T$$

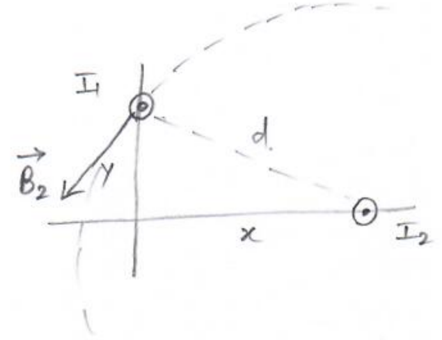
$$\vec{B}_2 = \frac{\mu_0 I_2}{2\pi y}\,\hat{i} + 0\,\hat{j} = \hat{i}\,6.7\,\mu T + 0\,\hat{j}$$

$$\vec{B}_{tot} = (6.7\,\hat{i} + 2.5\,\hat{j})\ \mu T$$

magnitude: $B_{tot} = \sqrt{6.7^2 + 2.5^2}$
$= 7.2\,\mu T$

direction: $\theta = \tan^{-1}\left(\frac{2.5}{6.7}\right)$
$= 21^\circ$ ccw w.r.t x.

Prob. 6



$$d = \sqrt{x^2+y^2} = \sqrt{8.0^2 + 6.0^2} = 10.\ \text{cm} = 0.10\text{m}$$

$$\vec{B}_2 = \hat{\phi}\ \frac{\mu_0 I_2}{2\pi d} = \hat{\phi}\ \frac{(4\pi\times10^{-7})(2.0)}{2\pi\ (0.10)}$$

$$= \hat{\phi}\ 4.0\,\mu T$$

$$\vec{F}_{12} = I_1 \vec{L}_1 \times \vec{B}_2$$

on 1 by 2

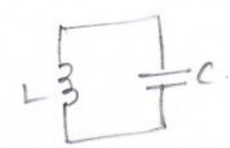
$$F_{12} = I_1 L_1 B_2 \sin 90$$

$$\frac{F_{12}}{L_1} = I_1 B_2 = (1.0)\ 4.0\times10^{-6} = 4.0\ \mu\frac{N}{m}$$

direction: towards I_1 along the line connecting I_1 and I_3.

The wires attract.

Prob. 7



$$-L\frac{dI}{dt} - \frac{Q}{C} = 0$$

$$\frac{d^2Q}{dt^2} = -\frac{1}{LC}Q \qquad \omega = \frac{1}{\sqrt{LC}}.$$

$$= -\omega^2 Q$$

$$\frac{[Q]}{T^2} = \frac{[Q]}{[LC]} \Rightarrow \left[\frac{1}{\sqrt{LC}}\right] = \frac{1}{T} = T^{-1}$$

$\omega = \frac{1}{\sqrt{LC}}$ represents the angular frequency of oscillations between charging and discharing of capacitor in an LC circuit.