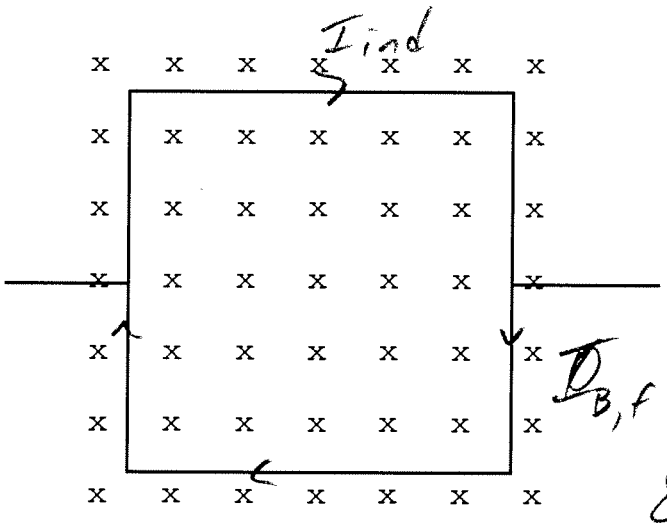
# Physics 10164 - Exam 3

Each problem is worth 25 points. Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work even if you get the right answer. Clearly indicate your answer with a circle of a box and remember to include correct units and significant figures.

1. A single-turn square loop, 75 cm on a side, is in the plane of the page. It has a resistance of 0.046 Ohms, and the loop is immersed in a uniform magnetic field of 3.5 Tesla pointing into the page as shown. The loop then rotates so that the top part of the loop comes out of the page, and the bottom part goes into the page. The loop rotates 90 degrees in 0.25 seconds.

Find the magnitude and direction of the induced current in the loop during this 0.25 second time interval.




$\mathcal{E} = \frac{\Delta \Phi_B}{\Delta t}$

$\Phi_{B,i} = B \cdot A$

$= (3.5)(.75)^2$

$= 1.97\ T \cdot m^2$

$\Phi_{B,f} = 0$

$\mathcal{E} = \frac{1.97}{0.25} = 7.88\ V$

$I_{ind} = \frac{7.88}{.046} = \boxed{171\ A}$

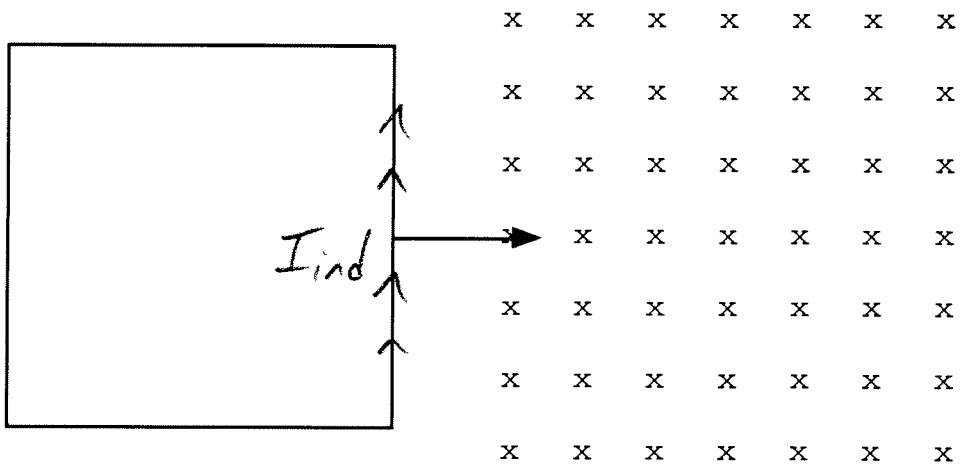
Dir: $\Phi_B = \times$, decreasing

so $B_{ind} = \times$, $I_{ind} = CW$

2. The square loop from problem 1 is now moving as shown into a uniform magnetic field of magnitude 3.5 Tesla pointing into the page. As the loop enters the field,

a) indicate the direction of the net force on the loop

b) If the loop moves with a speed of 2.1 meters/sec, find the magnitude and direction of the induced current while it is entering the field.




a) $\Phi_B$ = ↗, increasing, so $B_{ind}$ = ⊙

$I_{ind}$ = CCW

From RHR $\vec{F}_B = \vec{I} \times \vec{B}$

p t f palm points ←

b) $\mathcal{E}_{ind} = B\ell v$

$= (3.5)(.75)(2.1) = 5.5\ V$

$I_{ind} = \frac{5.5}{.046} =$ **120 A, CCW**

3. A resistor (550 Ohms), a capacitor (22 μF) and an inductor (850 mH) are connected in series across a 60-Hz source for which the rms voltage is 120 Volts.

a) Calculate the rms current in the circuit.

b) What is the rms current in the circuit if the frequency is changed to the resonant frequency?

$R = 550\ \Omega$

$X_C = \frac{1}{2\pi f C} = 120\ \Omega$

$X_L = 2\pi f L = 320\ \Omega$

$Z = \sqrt{550^2 + 200^2} = 585$

$I_{rms} = \frac{120}{585} = \boxed{0.21\ A}$

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If res, $Z = R = 550$

$I = \frac{120}{550} = \boxed{0.22\ A}$

4. A transformer at a power company steps up the voltage from 12,000 Volts to 240,000 Volts in order to transmit power across a power line with a resistance of 65 Ohms over many miles. The power company is providing 1.5 million Watts.

a) What percentage of power is lost in the power lines due to dissipation ($I^2R$)?

b) If the voltage were kept at its original level, what percentage of the power would be lost in the lines?

In line $P = I\Delta V$

$1.5 \times 10^6 = I(240000)$

$I = 6.25A$

$P_{lost} = I^2R = 2540\,W$

$\% = \frac{2540}{1.5 \times 10^6} = .00169$

$= 0.169\,\%$

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If $1.5 \times 10^6 = I(12000)$

$I = 125$

$P_{loss} = 1.0 \times 10^5$

$\% = 66\,\%$