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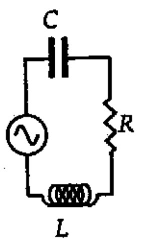


This alternating circuit contains an alternating power supply of frequency $f = 60$ Hz and maximum voltage $\mathcal{E}_0 = 5.0$ V; a resistor of resistance $R = 0.50\ \Omega$; a capacitor $C = 20\ \mu F$ (microfarads); and an inductor $L = 0.40$ H.

(a) What is the period of oscillation of this circuit? In other words, how much time does the current take to slosh back and forth, completing one cycle?

(b) During these oscillations, what is the biggest current that ever flows through the inductor?

(c) What is the largest power (rate of heat dissipation) reached in the resistor?

(d) *(Extra hard. Ask your instructor if you need to understand this.)* Suppose the power supply reaches its maximum voltage at time t_1. How long *after* time t_1 does the current through the resistor first reach its maximum value?

(e) The power supply is suddenly turned to zero. (But current can still flow through its inner workings.) Describe in words what happens to the current in the circuit over the next few tenths of a second. Sketch a rough, non-numerical graph of i vs. t. Is the period still the value you calculated in part **(a)**?

a) $T = \frac{1}{f} = \frac{1}{60\text{ Hz}} = 0.017\text{ s}$

b) $I_{max} = \frac{\overbrace{\mathcal{E}_{max}}^{\to 5V}}{\underbrace{Z}_{\text{need to find this}}}$

$$Z = \sqrt{R^2 + (\omega L - 1/\omega C)^2}$$

$$\omega = 2\pi f = 2\pi(60)\text{ rad/s}$$

Plugging in, get $Z = 18.2\ \Omega$

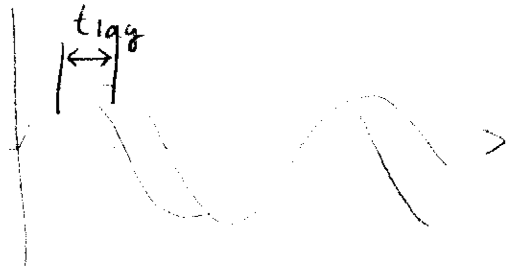
$$I_{max} = \frac{5V}{18.2\ \Omega} = 0.27\text{ A}$$

(What if C & L weren't there? Would get

$I_{max} = \frac{\mathcal{E}_{max}}{R} = 10\text{ A}$. Effect of C, L is to make current <u>less</u>)

c) $P_{max} = I_{max}^2 R = 0.038\text{ W}$

d)



One period T corresponds to 2π change in ϕ

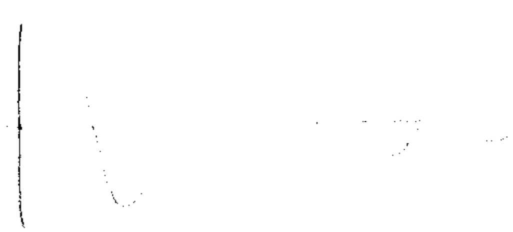
$$\frac{\phi}{2\pi} = \frac{t_{lag}}{T}$$

$$t_{lag} = \frac{\phi}{2\pi} T$$

$$\phi = \tan^{-1}\left(\frac{\omega L - 1/\omega C}{R}\right) = 88^\circ$$

$$t_{lag} = \frac{88^\circ}{360^\circ}(0.017) = \underline{0.0041\ s}$$

e) Mechanical analogy: like letting go of a block on a spring with damping



System will oscillate at (nearly) its natural frequency (not the supply frequency)