PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Fall Semester 2016**

College of Sciences

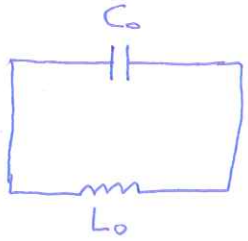
Section **Quiz 11** **30 December 2016**

Closed book. No calculators are to be used for this quiz.

Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

An LC circuit containing an inductor L_0 and a capacitor C_0 oscillates with a maximum current of I_0. Assuming the capacitor has its maximum charge at time $t = 0$, calculate the energy stored in the inductor after t seconds.



$I(t) = I_0 \cos(\omega_0 t + \phi)$

where $\omega_0 = \frac{1}{\sqrt{LC}}$.

$V(t) = L_0 \frac{dI}{dt} = -\omega_0 L_0 I_0 \sin(\omega_0 t + \phi)$

$V(t) = \frac{Q(t)}{C} \Rightarrow Q(t) = V(t) C_0$

$Q(t=0) = -\omega_0 I_0 \sin(\phi) \cdot C_0$

for max charge at $t=0$,

$\sin(\phi) = -1$

$\phi = \frac{3\pi}{2}$

Energy stored in the inductor:

$E_{ind} = \frac{1}{2} L I^2$

At time t:

$E_{ind}(t) = \frac{1}{2} L_0 I_0^2 \cos^2\left(\frac{t}{\sqrt{LC}} + \frac{3\pi}{2}\right)$

PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Fall Semester 2016**

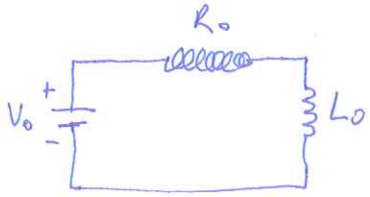
College of Sciences

Section 1 **Quiz 11** **23 December 2016**

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

Name: **Student ID:** **Signature:**

An ideal battery with voltage V_0, a resistor with resistance R_0, and an ideal inductor with inductance L_0 are all connected in series with an open switch. The switch is suddenly closed. How long after closing the switch will the current through the inductor reach one-half of its maximum value?



$$V_0 - iR_0 - L_0\frac{di}{dt} = 0$$

$$V_0 - iR_0 = L\frac{di}{dt}$$

$$\frac{dt}{L_0} = \frac{di}{V_0 - iR_0}$$

$$\int_0^t \frac{dt}{L_0} = \int_0^i \frac{di}{V_0 - iR_0}$$

$$\frac{t}{L_0} = -\frac{1}{R_0}\ln(V_0 - iR_0)\Big|_0^i$$

$$\vdots$$

$$i = \frac{V_0}{R_0}\left(1 - e^{-\frac{R_0 t}{L_0}}\right)$$

For max i, $\left(1 - e^{-\frac{R_0 t}{L_0}}\right) = 0$

$$i_{max} = \frac{V_0}{R_0}$$

For half of max:

$$\frac{i_{max}}{2} = i_{max}\left(1 - e^{-\frac{R_0 t}{L_0}}\right)$$

$$1 - e^{-R t/L} = \frac{1}{2}$$

$$e^{-\frac{R_0 t}{L_0}} = \frac{1}{2}$$

$$-\frac{R_0 t}{L_0} = \ln(0.5)$$

$$t = -\frac{L_0 \ln(0.5)}{R_0}$$