

FIFTH MIDTERM Answer

2

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Discussion Section # _____

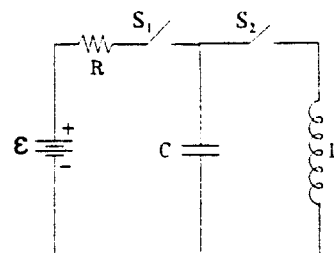
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SHOW ALL WORK!!!!

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!

Use the conversion constants and data given on the front page.

In the drawing shown, the switch S_1 is closed for a long time with S_2 open. At $t = 0$ S_1 is opened and then S_2 is closed.



- (a) Write an expression with numerical values for the charge on the capacitor as a function of time.
 (b) Calculate the maximum energy stored in the inductor.
 (c) Calculate the maximum value of the current in the inductor.

$\epsilon = 250 \text{ V}$
 $R = 175 \Omega$
 $L = 87.0 \text{ mH}$
 $C = 140 \text{ pF}$

(10) (a) $U_0 = \epsilon = 250 \text{ V}$
 $L \frac{d^2 Q}{dt^2} + \frac{Q}{C} = 0$

$Q(t) = Q_0 \cos(\omega t + \phi_0)$, $Q_0 = CU_0 = 140 \times 10^{-12} \times 250 = 3.50 \times 10^{-8} \text{ (C)}$
 $\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{87.0 \times 10^{-3} \times 140 \times 10^{-12}}} = 2.87 \times 10^5 \text{ (s}^{-1}\text{)}$

$\phi_0 = 0$

So $Q(t) = \cancel{140 \times 10^{-12}} 3.5 \times 10^{-8} \cos(2.87 \times 10^5 t) \text{ (C)}$

(5) (b) $E_{\text{max}} = \frac{1}{2} \frac{Q_0^2}{C} = \frac{1}{2} \times \frac{(3.50 \times 10^{-8})^2}{140 \times 10^{-12}} = 4.38 \times 10^{-6} \text{ (J)}$

(10) (c) $I = -I_{\text{max}} \sin \omega t = -\frac{CU_0}{\sqrt{LC}} \sin \omega t = -Q_0 \omega \sin \omega t$,

$I_{\text{max}} = Q_0 \omega = 3.50 \times 10^{-8} \times 2.87 \times 10^5 = 0.0100 \text{ (A)}$

[or $\frac{1}{2} \frac{Q_0^2}{C} = \frac{1}{2} L I_{\text{max}}^2$, $I_{\text{max}} = \sqrt{\frac{Q_0^2}{LC}} = \dots = 0.0100 \text{ (A)}$]