Physics 2220
Spring 2002
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FIFTH MIDTERM

4

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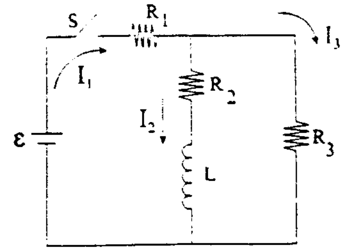
Discussion Section # ____________ Student ID #: ____________

SHOW ALL WORK!!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

For the circuit shown, the switch S is closed at t = 0 after being open for a long time.



5 (a) Just after t = 0, calculate the current in R_3.

5 (b) At t = ∞ calculate the current in R_3.

5 (c) At t = ∞ the switch is opened. Calculate the magnitude of the current in R_3 1.5 time constants after the switch is opened.

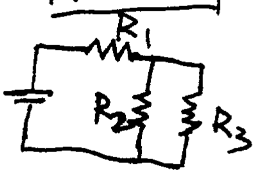
10 (d) When the switch is closed at t = 0, calculate the time constant (numerical value) for the growth of current in the inductor. Use full loops and junctions with no short cuts. Use the current designations given.

ε = 150 V; R_1 = 125 Ω; R_2 = 175 Ω; R_3 = 200 Ω; L = 18.0 mH

(a) At t=0, No current flows through R_2 and L,

$$I_3 = \frac{\varepsilon}{R_1+R_3} = \boxed{0.462\,A}$$

(b) At t=∞,



$$I_3 = \frac{\varepsilon}{R_1+\frac{R_2\cdot R_3}{R_2+R_3}}\cdot\frac{R_2}{R_2+R_3} = \boxed{.321\,A}$$

$$I_1 = \frac{\varepsilon}{R_1+\frac{R_2\cdot R_3}{R_2+R_3}} = 0.687\,A$$

$$I_2 = I_1 - I_3 = 0.366\,A$$

(c) $I = I_2 e^{-1.5\tau/\tau} = I_2 e^{-1.5} = \boxed{0.082\,A}$

(d)
$$\begin{cases} I_1 = I_2 + I_3 \\ \varepsilon = I_1R_1 + I_3R_3 \\ I_3R_3 = I_2R_2 + L\frac{dI_2}{dt} \end{cases}$$

$$\varepsilon = I_2R_1 + \frac{R_1+R_3}{R_3}R_2I_2 + \frac{R_1+R_3}{R_3}L\frac{dI_2}{dt}$$

$$\frac{dt}{L\frac{R_1+R_3}{R_3}}\cdot\left(R_1+\frac{R_2R_1}{R_3}+R_2\right) = -\frac{dI_2}{I_2-\frac{\varepsilon}{R_1+\frac{R_2R_1}{R_3}+R_2}}$$

$$\boxed{\tau = \frac{L(R_1+R_3)}{R_1R_3+R_1R_2+R_2R_3}}$$

$$\boxed{= 7.15\times10^{-5}\,s}$$