Physics 2220
Spring 2000
George A. Williams

FINAL EXAM

30

3

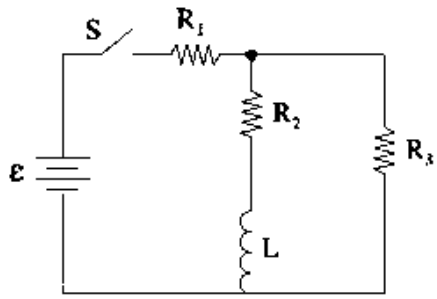
Name: Eric Bulson

Discussion Instructor (circle): Billeter Bulson Muntean Paul Pomeroy

Discussion Section # _____

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

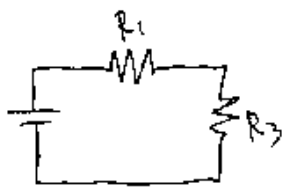
For the circuit shown the switch is open for a long time, and closed at t = 0.



(a) Calculate the current in R_3 at t = 0.
(b) Calculate the current in R_2 at t = ∞.
(c) Calculate the current in R_2 at t = 2τ (two time constants).
(d) If the switch is closed for a long time and then opened at t = 0 (a new t =0), find a complete expression with all constants evaluated for the current in R_2.

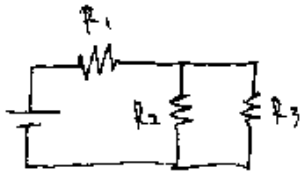
R_1 = 250 Ω; R_2 = 550 Ω; R_3 = 450 Ω; ε = 135 V; L = 4.20 mH

5 a.)



$$I_3 = \frac{\mathcal{E}}{R_1 + R_3} = \frac{135}{250+450} = \boxed{0.193\ A}$$

10 b.)



$$I_{tot} = \frac{\mathcal{E}}{R_1 + \frac{R_2 R_3}{R_2 + R_3}}$$

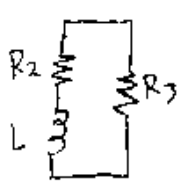
$$V_2 = I_{tot}\left(\frac{R_2 R_3}{R_2 + R_3}\right)$$

$$I_2 = \frac{V_2}{R_2} = \frac{1}{R_2}\left(\frac{\mathcal{E}}{R_1 + \frac{R_2 R_3}{R_2+R_3}}\right)\left(\frac{R_2 R_3}{R_2+R_3}\right) = \boxed{0.122\ A}$$

5 c.) $I_2(t) = I_\infty\left(1 - e^{-t/\tau}\right)$

with $I_\infty = 0.122\ A$, at $t = 2\tau$ we have: $I_2(2\tau) = 0.122\left(1 - e^{-2}\right) = \boxed{0.106\ A}$

10 d.)



$$I_2(t) = I_{2i}\, e^{-t/\tau}$$

$$\tau = \frac{L}{R_2 + R_3} = \frac{4.20\ mH}{550\Omega + 450\Omega} = 4.2 \times 10^{-6}\ s$$

$$\therefore\ I_2(t) = 0.122\left(e^{-\frac{t}{4.2\mu s}}\right)\ A$$