UCLA

Department of Electrical Engineering

EE10 Midterm 2 Spring 2011

Instructor: Prof. Gupta May 18th, 2011

1. Exam is closed book. You are allowed **one 8 ½ x 11" double-sided cheat sheet**.
2. Calculators are allowed.
3. **Cross out everything that you don't want me to see. Points will be deducted for everything wrong!**
4. **Do NOT use Laplace Transforms to solve any problems.**

Name:

Student ID: Solution

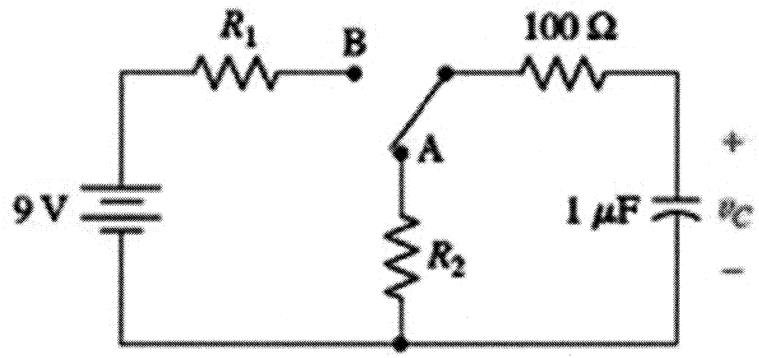
Student on Left:

Student on Right:

Student in Front:

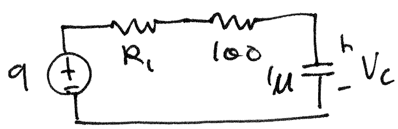
Problem	Maximum Score	Your Score
1	10	
2	6	
3	8	
4	6	
Total	30	

Q1. (10 points) The switch in the circuit below has been in position A for long time. It is switched to position B at t=0 and back to position A at t=1ms. Find R1 and R2 such that $v_c(1\text{ms}) = 8\text{V}$ and $v_c(2\text{ms}) = 1\text{V}$.



$V_c(0-) = V_c(0+) = 0$

i) $0 < t \leq 1ms$



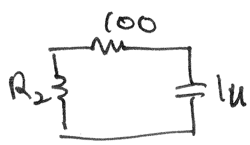
$$\frac{V_c - 9}{R_1 + 100} + 1\times10^{-6}\frac{dV_c}{dt} = 0 \Rightarrow \frac{dV_c}{dt} + \frac{1}{\tau_1}V_c = \frac{9}{R_1+100}, \quad \tau_1 = (R_1+100)\times 1\mu$$

$\therefore V_c(t) = 9(1 - e^{-\frac{t}{\tau_1}})$, $0 < t \leq 1ms$

$V_c(1ms) = 9(1 - e^{-\frac{1m}{\tau_1}}) = 8 \Rightarrow e^{-\frac{1m}{\tau_1}} = \frac{1}{9}$

$\therefore R_1 = 355.12$

ii) $t > 1ms$



$$\frac{V_c}{R_2+100} + 1\times10^{-6}\frac{dV_c}{dt} = 0$$

$\Rightarrow V_c(t) = k_1 e^{-\frac{t-1m}{\tau_2}}$, $\tau_2 = (R_2+100)\times 1\mu$

$V_c(1ms) = k_1 = 8$

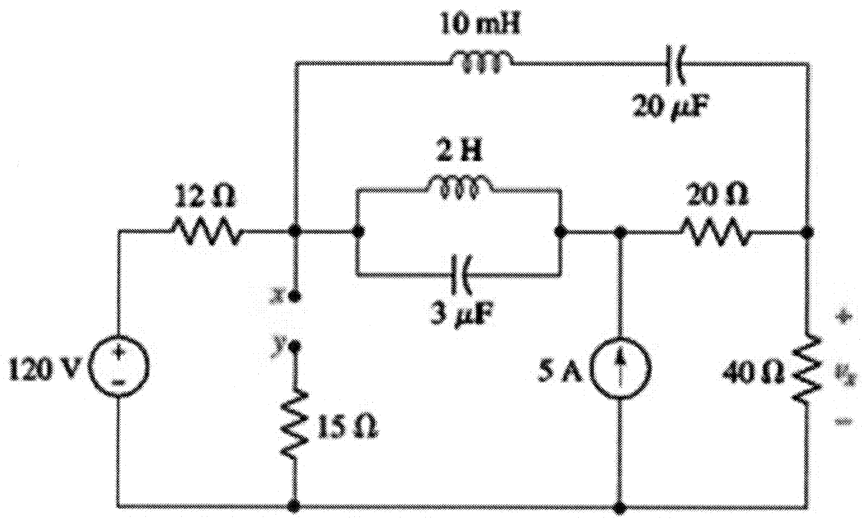
$\therefore V_c(t) = 8e^{-\frac{t-1m}{\tau_2}}$

$V_c(2ms) = 8e^{-\frac{1m}{\tau_2}} = 1$

$\therefore R_2 = 380.9$

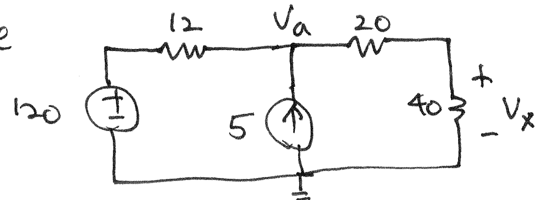
R1 =	355.12 Ω
R2 =	380.9 Ω

Q2. (6 points) A long time after the connections have been made, find out the value of v_x if there is a Capacitor is present between x and y.



After making capacitor open-circuit and inductor short circuit,

we have

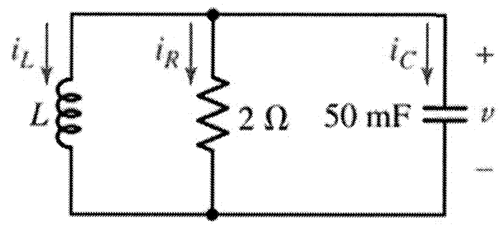


$$\frac{V_a - 120}{12} + \frac{V_a}{60} = 5 \quad \Rightarrow V_a = 150V$$

$$V_x = \frac{2}{3} V_a = 100V$$

Vx = 100V

Q3. (8 points) For the circuit of Fig. below, the value of the inductance is 1250 mH. Determine v(t) if it is known that the capacitor initially stores 390 J of energy and the inductor initially stores zero energy.



$\frac{1}{2}CV^2 = \frac{1}{2}\times 0.05 \times V^2 = 390 \quad \Rightarrow \quad V_C(0-) = V_C(0+) = 20\sqrt{39}$

$i_L(0-) = i_L(0+) = 0$

From KCL,

$$\frac{v}{2} + 0.05\frac{dv}{dt} + \frac{1}{1.25}\int_0^t v\,dt = 0 \quad \Rightarrow \quad \frac{V(0+)}{2} + 0.05\frac{dV(0+)}{dt} + \frac{1}{1.25}\int_0^0 v\,dt = 0$$

$$\therefore \frac{dv(0+)}{dt} = -200\sqrt{39}$$

$$\Rightarrow \quad \frac{d^2v}{dt^2} + 10\frac{dv}{dt} + 16v = 0$$

$s^2 + 10s + 16 = 0 \qquad s_{1,2} = -2, -8$

$V(t) = k_1 e^{-2t} + k_2 e^{-8t}$

$V(0+) = k_1 + k_2 = 20\sqrt{39}$

$\frac{dv(0+)}{dt} = -2k_1 - 8k_2 = -200\sqrt{39}$

$\Rightarrow \quad k_2 = \frac{80}{3}\sqrt{39} = 166.5$

$k_1 = -\frac{20}{3}\sqrt{39} = -41.6$

$\boxed{\textbf{V(t)} = -41.6\,e^{-2t} + 166.5\,e^{-8t} \text{ or } -\frac{20}{3}\sqrt{39}\,e^{-2t} + \frac{80}{3}\sqrt{39}\,e^{-8t}}$

Q4. (6 points) You found a rather strange piece of circuitry which three exposed terminals (x,y,z) and it has exactly one resistor, one inductor, and one capacitor, but you don't know how they are connected. The resistances (measured by applying a 1V DC source) between the terminals of the mystery circuit are as follows:

x – y: infinity, y – z: infinity, z – x: 10

Draw all possible connections of the three elements with x, y, z clearly labeled which would satisfy above. No points given without explanations.

Since the resistances are measured by applying a 1V DC source, the resistances of a capacitor and an inductor are infinity and zero, respectively.

1. The capacitor has to be placed between x-y and y-z, but not between z-x.
2. The resistor has to be placed between z-x.

From these two conditions, we can have two possible connections: