EE10 Midterm 2

Department of Electrical Engineering, UCLA

Winter 2013

Instructor: Prof. Gupta

Duration: 60 mins

1. Exam is closed book. Calculator and one double-sided cheat-sheet are allowed.
2. Cross out *everything* that you don't want me to see. Points will be deducted for everything wrong!
3. Do NOT use Laplace Transforms to solve any problems.
4. No points will be given without proper explanations.

Name:

Student ID:

Student on Left:

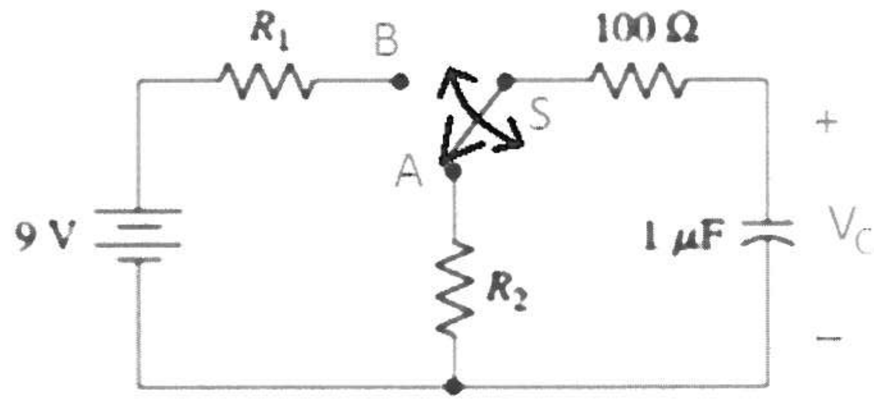
Student on Right:

Student in Front:

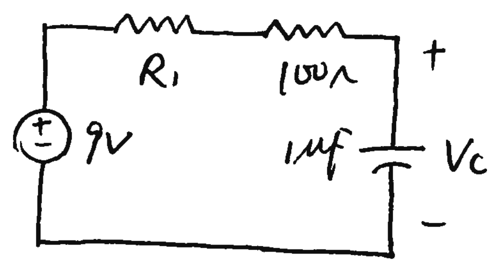
Problem	Maximum Score	Your Score
1	20	
2	10	
3	10	
Total	40	

Question 1 (20 points)

The switch S in the circuit below has been at position A for a long time. At $t = 0s$ S is switched from A to B. Again at $t = 1ms$ S is switched back to A from B. Find values of resistances R_1 and R_2 such that $V_C(1ms) = 5.69V$ and $V_C(2ms) = 2.09V$.



For $0<t<1ms$ we have



$V_c(\infty) = 9V$

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

$\tau_1 = (R_1 + 100)C$

$$V_c(t) = V_c(\infty) - [V_c(\infty) - V_c(0^+)]e^{-\frac{t}{\tau_1}} = 9(1-e^{-\frac{t}{\tau_1}})$$

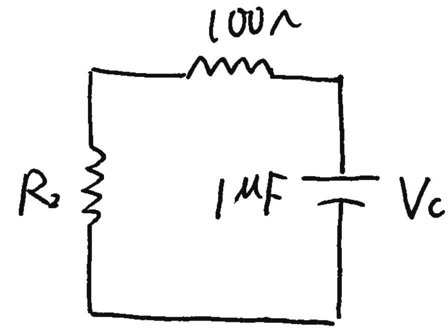
Given $V_c(1ms) = 5.69V \Rightarrow 9(1-e^{-\frac{1ms}{\tau_1}}) = 5.69$

$\Rightarrow \tau_1 = 1ms = (R_1 + 100) \times 10^{-6}$

$\Rightarrow R_1 + 100 = 10^3$

$\Rightarrow R_1 = 900\Omega$

For $1ms < t < \infty$



$V_c(\infty) = 0V$

$V_c(1ms^+) = 5.69$ (Given)

$\tau_2 = (R_2 + 100)C$

so $V_c(t) = 5.69 e^{-\frac{(t-1ms)}{\tau_2}}$ $(t > 1ms)$

Given $V_c(2ms) = 2.09V$

$\Rightarrow 5.69 e^{-\frac{1ms}{\tau_2}} = 2.09$

$\Rightarrow \tau_2 = 1mS = (R_2 + 100) \cdot 10^{-6}$

$\Rightarrow R_2 + 100 = 10^3$

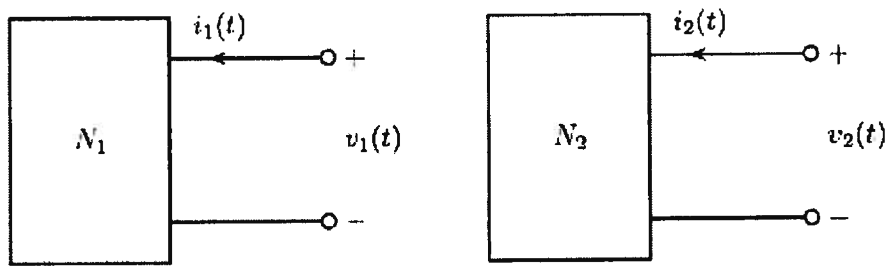
$\Rightarrow R_2 = 900\Omega$

R1 = 900Ω
R2 = 900Ω

Question 2 (10 points)

Consider a two terminal network, which have v-i relations as follows

N_1: $v_1(t) = 4i_1(t) - 8$ N_2: $v_2(t) = 2i_2(t) + 3$



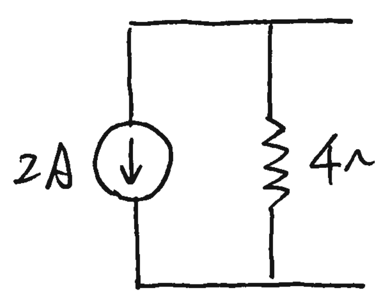
(a) What is the Norton equivalent for N_1? (3 points)

Open circuit: $i_1(t) = 0 \Rightarrow V_{oc} = -8V$

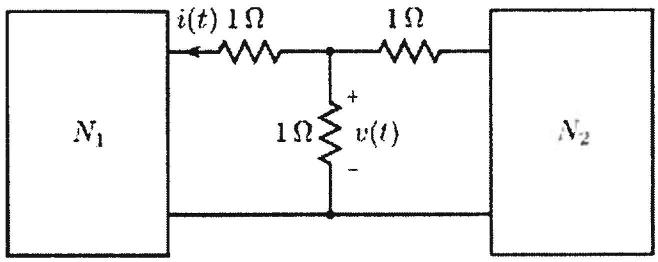
short circuit: $v_1(t) = 0 \Rightarrow i_{sc} = -i_1(t) = -2A$

$$R_{th} = \frac{V_{oc}}{i_{sc}} = \frac{-8V}{-2A} = 4\Omega$$

Norton equivalent for N_1

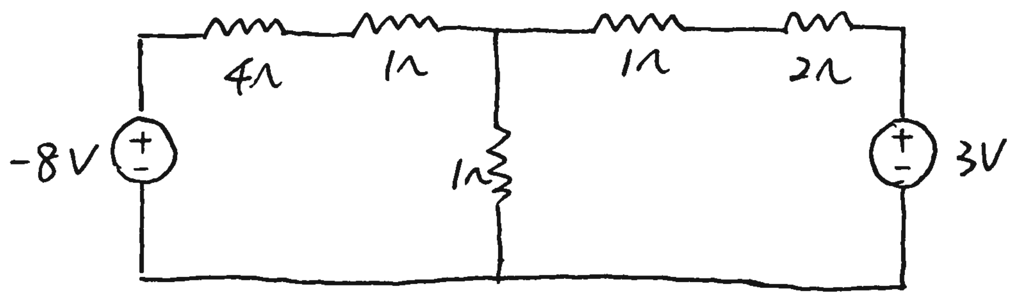


(b) Determine v(t) and i(t) if the two networks are connected as below. (7 points)



For N_1, $V_{th} = -8V$ $R_{th} = 4\Omega$

For N_2: $V_{th} = 3V$ $R_{th} = 2\Omega$



$$\frac{V-(-8)}{5} + \frac{V-3}{3} + \frac{V}{1} = 0$$

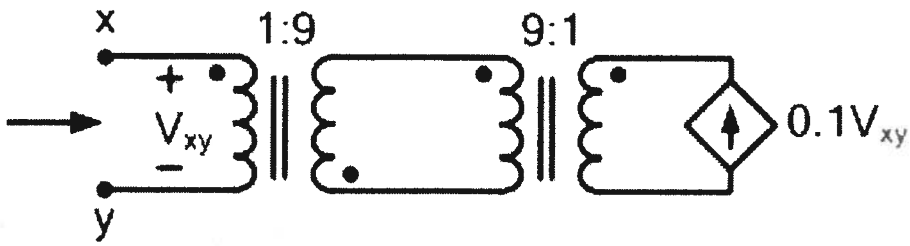
$$V(t) = -\frac{9}{23} V$$

$$i(t) = \frac{V-(-8)}{5} = \frac{35}{23} A$$

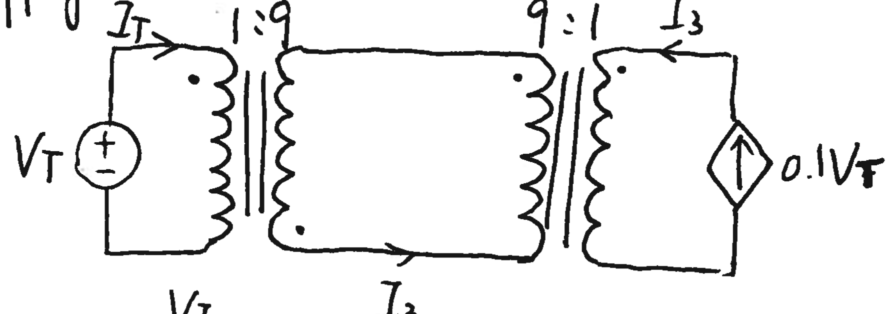
v(t) =
i(t) =

Question 3 (10 points)

Find the Thevenin equivalent seen between nodes x and y. Assume that the transformers are ideal.



Apply test source V_T



$Z_{xy} = \frac{V_T}{I_T}$

For ideal transformer. $I_2 = \frac{1}{9} I_1 = I_T/9$

$I_3 = 9I_2 = \frac{1}{9} I_T \cdot 9 = I_T$

And $I_3 = 0.1V_{xy} = 0.1V_T = I_3 = I_T$

Therefore $Z_{xy} = \frac{V_T}{I_T} = 10\,\Omega$

$V_{xy} = 0\,V$ since no independent source

Thevenin equivalent