ECE10 Midterm I

Department of Electrical Engineering, UCLA

Spring 2019

Instructor: Prof. Gupta

1. Exam is closed book. Calculator and one double sided cheat-sheet is allowed.
2. Cross out *everything* that you don't want me to see. Points will be deducted for everything wrong!
3. No points will be given without proper explanations
4. Time allotted: 75 minutes

Name: Hai

Studer

Studer

Studer

Studer

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

Q1. (2+2+2+2 =8 points)

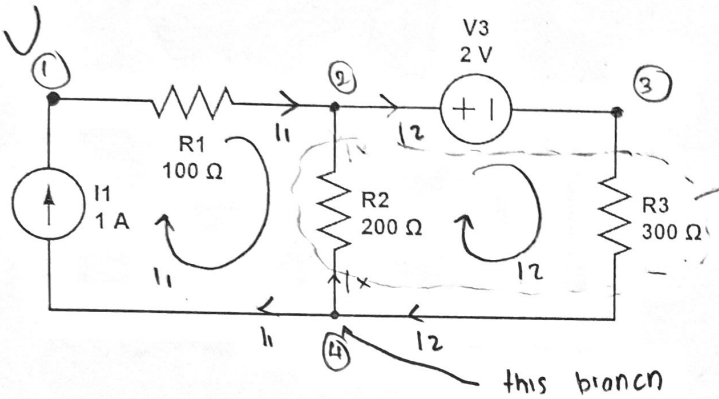
For this circuit, please answer the following questions:

a) How many nodes and how many branches?

b) Please draw the equivalent graph after killing the independent sources.

c) Please draw ONE spanning tree for the graph.

d) Write the KVL equations based on the cut-set. Clearly mark which branch is the loop current flowing in.



Finding i_x

this branch

a) 4 nodes, 5 branches

(b) Killing all independent sources

using Kruskal's algorithm with equal weight for each vertical branch

3 nodes, 2 branches

(c) Spanning Tree

minimum KVL equations : b − n − 1 = 3 − (2 − 1) = 2

(d) 1 chord

KVL equation between loop

$$-I_2(300) - (I_2 - I_1)200 - 2 = 0 \quad -(1)$$

$$(V_1 - V_0) - I_1(100) = -(I_2 - I_1)(200)$$

$$V = (I_1 - I_2)(200) + I_1(100)$$

$$V = 200I_1 + 100I_1 - 200I_2$$

$$V_1 = 300I_1 - 200I_2$$

$$I_x + I_1 = I_2$$

$$I_x = I_2 - I_1$$

$$I_1 = A$$

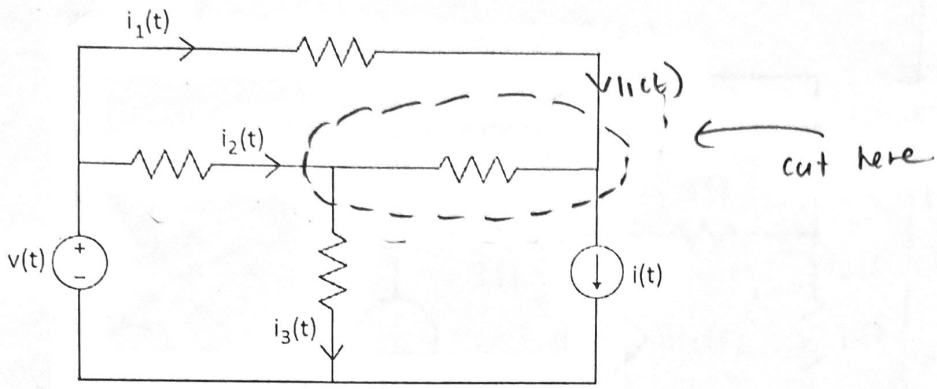
Second KVL equation

$$(300I_1 - 200I_2) - (100I_1) + (I_2 - I_1)(200) = 0 \quad -(2)$$

or $V_1 - I_1(100) + (I_2 - I_1)(200) = 0$

Q2. (4 points)

Draw the cutset relating i1, i2, i3 and wrote exactly ONE KCL equation corresponding to the cutset.



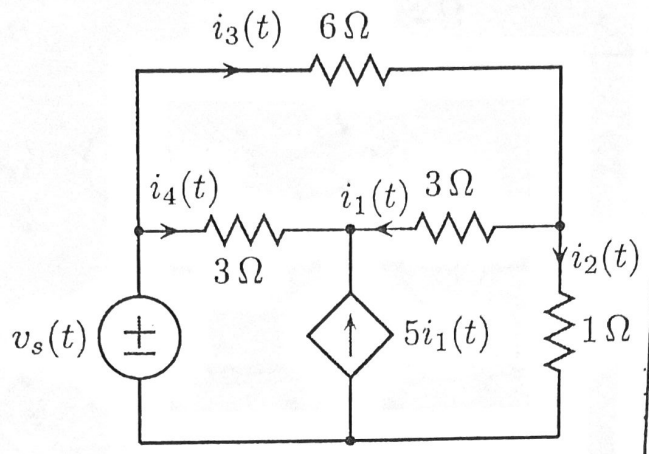
our cutset

by supernodal analysis,

$$i_1(t) + i_2(t) = i_3(t) + i(t)$$

Q3. 8 points

Find i_1 in terms of v_s using source transformations.



$v' = 15i_1(t) + v_s$

$\frac{v_s}{7} - (15i_1 + v_s) = i_1(t)\ \frac{48}{7}$

$-\frac{6}{7}v_s = i_1(t)\left[\frac{48}{7} + 15\right]$

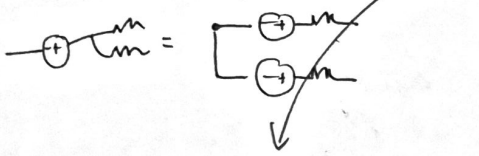
$\frac{153}{7}i_1(t) = -\frac{6}{7}v_s$

$i_1(t) = -\frac{2}{51}v_s$ A

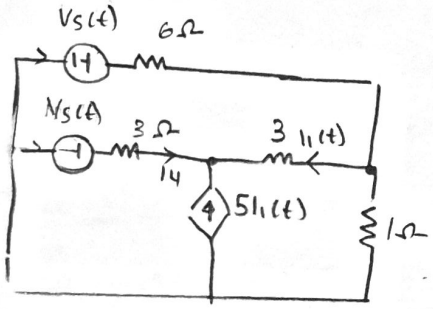
Answer ↑

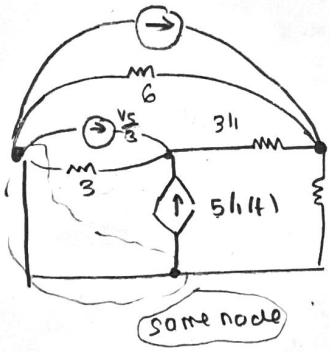
or $i_1(t) = -0.0392 v_s$ A

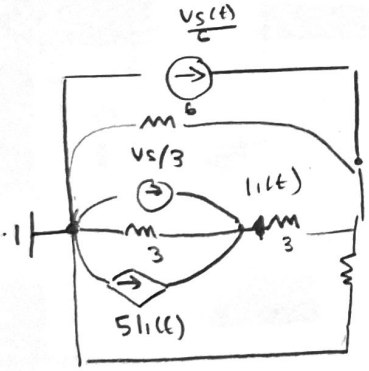
Vs transformation

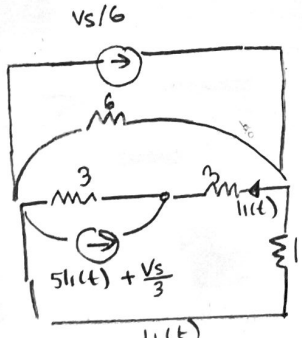


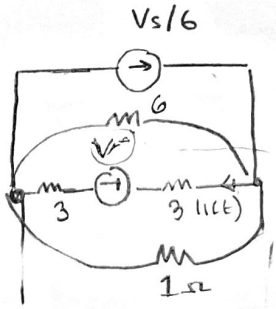
$I = \frac{V_s(t)}{6}$





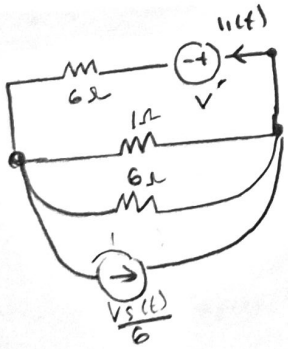


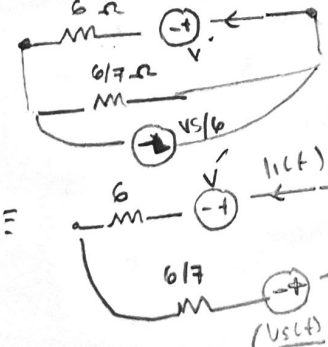


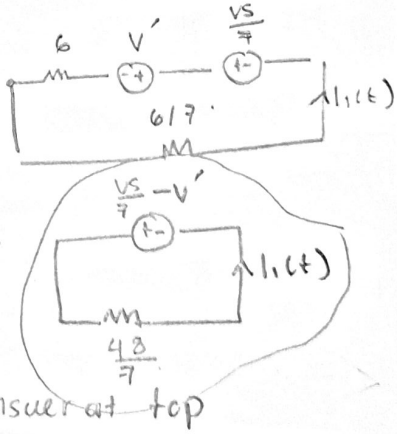


$\left(v' = \left(5i_1(t) + \frac{V_s}{3}\right)3\right)$

$v' = 15i_1(t) + v_s$



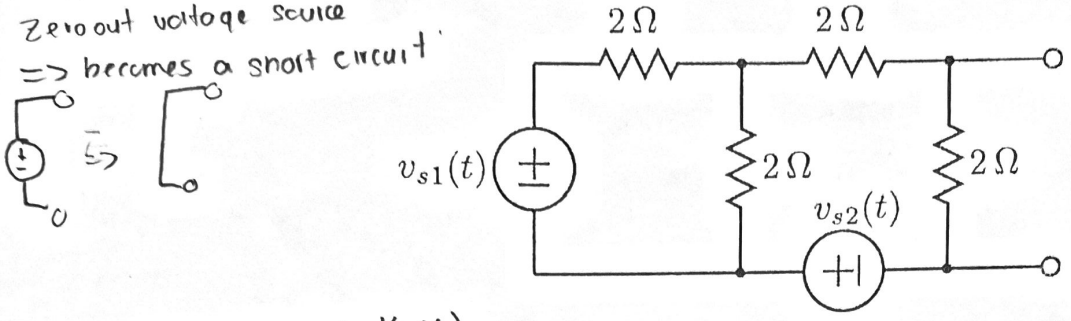




answer at top

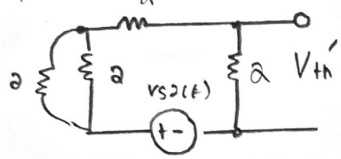
Q4. 10 points

Find the thevenin equivalent of the circuit below at the two nodes on the right using superposition.



Zero out voltage source
=> becomes a short circuit

Superposition : zero out $V_{s1}(t)$



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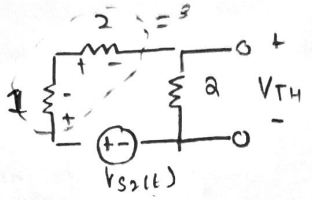
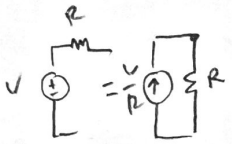


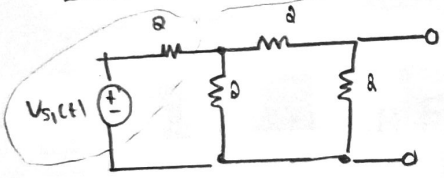
using voltage divider equation/

$$V_{TH}' = \frac{2}{2+2+1} V_{s2}(t)$$

$$\boxed{V_{TH}' = \frac{2}{5} V_{s2}(t)}$$



Zero-out $V_{s(2)}(t)$



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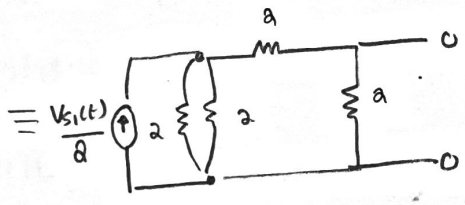

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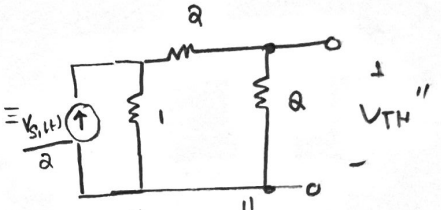
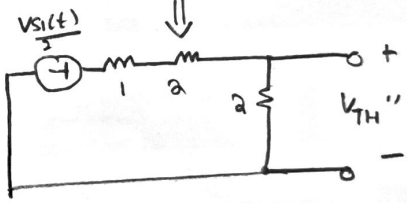
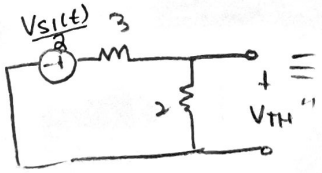




by voltage divider equation,

$$V_{TH}'' = \frac{2}{2+2+1}\left(\frac{V_{s1}(t)}{2}\right)$$

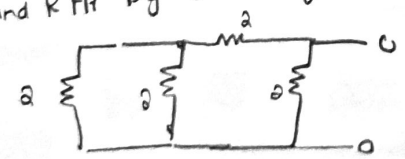
$$\boxed{V_{TH}'' = \frac{1}{5} V_{s1}(t)}$$



by superposition, we get :

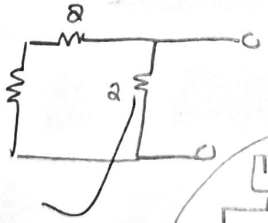
$$\boxed{V_{TH} = V_{TH}' + V_{TH}'' = 0.4\, V_{s2}(t) + 0.2\, V_{s1}(t)}$$

Find R_{TH} by disabling all indep sources



$2 \| 2 = 1$

$\equiv$



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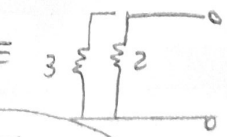
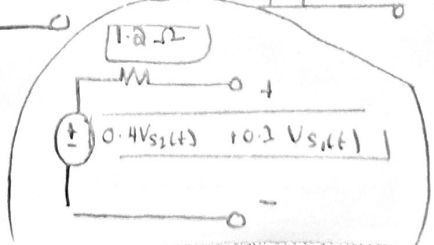


$$3 \| 2 = \frac{3 \cdot 2}{3+2} = \frac{6}{5}$$

$$\boxed{R_{TH} = 1.2\ \Omega}$$

$\therefore$ Thevenin equivalence



← answer