EECS70A Spring 2010 **Midterm Exam #2**

5/20/2010 8:00 to 9:20 am

Professor Peter Burke

Name: Solutions

ID no.:

1	2	3	4	5	Total
/20	/20	/20	/20	/20	/100

DO NOT BEGIN THE EXAM UNTIL YOU ARE TOLD TO DO SO.

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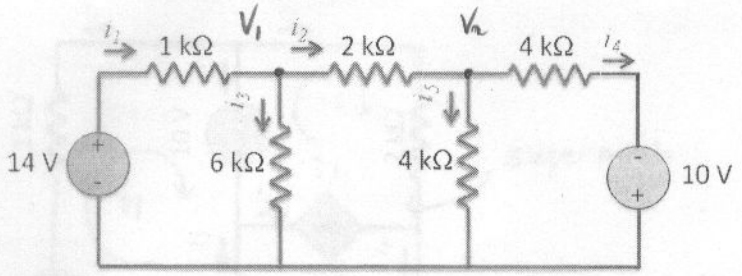
PROBLEM ONE:

Using nodal analysis, find the nodal voltages and all the currents (i_1-i_5) in this circuit.



$$\frac{V_1}{6k\Omega} + \frac{V_1 - 14}{1k\Omega} + \frac{V_1 - V_2}{2k\Omega} = 0$$

$$V_1 + 6V_1 - 84 + 3V_1 - 3V_2 = 0$$

$$10V_1 - 3V_2 = 84$$

$$10(2V_2 + 5) - 3V_2 = 84$$

$$20V_2 + 50 - 3V_2 = 84$$

$$\boxed{V_2 = \frac{34}{17} = 2V}$$

$$\frac{V_2}{4k\Omega} + \frac{V_2 + 10}{4k\Omega} + \frac{V_2 - V_1}{2k\Omega} = 0$$

$$V_2 + V_2 + 10 + 2V_2 - 2V_1 = 0$$

$$4V_2 - 2V_1 = -10$$

$$2V_2 - V_1 = -5$$

$$V_1 = 5 + 2V_2$$

$$\boxed{V_1 = 5 + 4 = 9V}$$

$$i_1 = \frac{14 - 9}{1K} = \boxed{5mA}$$

$$i_2 = \frac{9 - 2}{2k\Omega} = \boxed{3.5mA}$$

$$i_3 = \frac{9}{6k\Omega} = \boxed{1.5mA}$$

$$i_4 = \frac{2 + 10}{4k\Omega} = \boxed{3mA}$$

$$i_5 = \frac{2V}{4k\Omega} = \boxed{0.5mA}$$

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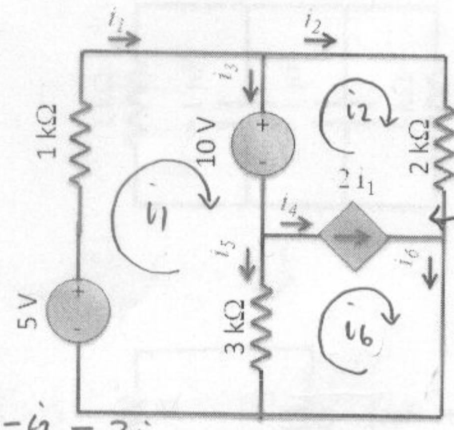
PROBLEM TWO:

Use mesh analysis to find the currents i_1-i_6, then find the power dissipated in the 2kΩ resistor.



supermesh

power dissipated in 2kΩ resistor:

$P = I^2 R = (5mA)^2 \cdot 2k\Omega$

$= 50mW$

Supermesh: $i_6 - i_2 = 2i_1$

mesh1: $-5 + 1k\Omega(i_1) + 10 + 3k(i_1 - i_6) = 0$

$4k\Omega\, i_1 - 3k i_6 = -5$

$4k\Omega i_1 - 3k(2i_1 + i_2) = -5$

$2ki_1 + 3ki_2 = 5$ $\qquad i_1 = \frac{5 - 3ki_2}{2k}$

mesh2: $3k(i_6 - i_1) - 10 + 2k(i_2) = 0$

$2ki_2 + 3ki_6 - 3ki_1 = 10$

$2ki_2 + 3k(2i_1 + i_2) - 3ki_1 = 10$

$5ki_2 + 3ki_1 = 10$

$5ki_2 + 3k\left(\frac{5 - 3ki_2}{2k}\right) = 10$

$5ki_2 + \frac{15 - 9ki_2}{2k} = 10$

$10ki_2 + 15 - 9ki_2 = 20$

$i_2 = 5mA$

$i_5 = i_1 - i_6 = -5 - -5 = \emptyset mA$ $\quad i_5 =$

$i_3 = i_1 - i_2 = -5mA - 5mA$

$= -10mA = i_3$

$i_1 = \frac{5 - 3k(5mA)}{2k}$

$= \frac{-10}{2k} = -5mA = i_1$

$i_6 = 2i_1 + i_2 = -10mA + 5mA = -5mA = i_6$

$i_4 = 2i_1 = -10mA = i_4$

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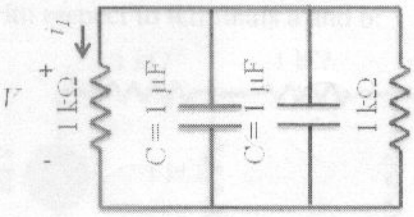
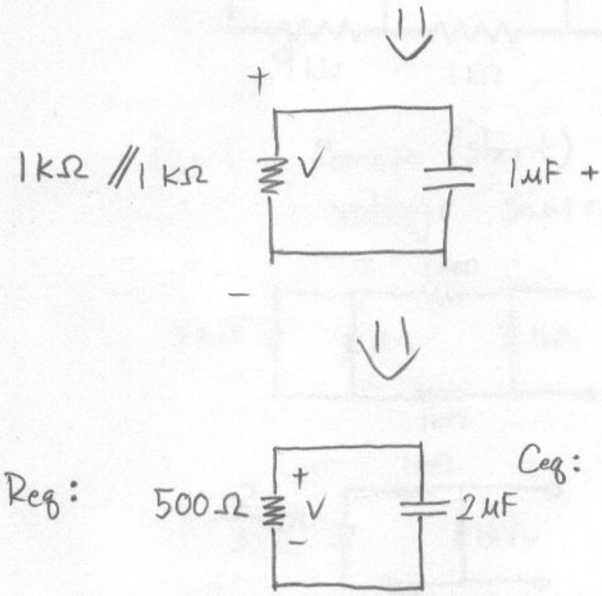
PROBLEM THREE:

Find V(t), $i_1(t)$, given that V(t=0) = 5 V.





$$V(t) = V(0)\, e^{-\frac{t}{RC}} \quad V$$

$$V(t=0) = V(0) = 5$$

Req : 500Ω

Ceq : 2μF

$$\tau = RC = 500 \cdot 2 \cdot 10^{-6} = 0.001$$

$$V(t) = 5e^{-\frac{t}{0.001}}$$

$$\boxed{V(t) = 5e^{-1000t} \quad V}$$

$$i_1(t) = \frac{V(t)}{1000\Omega}$$

$$\boxed{i_1(t) = 0.005e^{-1000t} \quad A}$$

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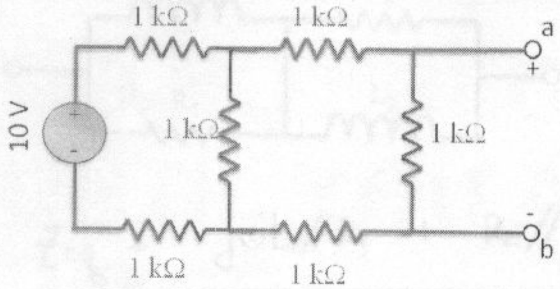
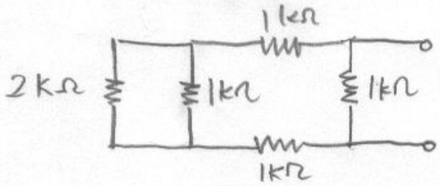
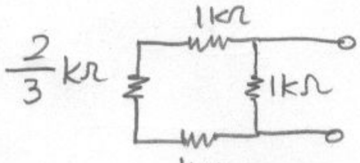
PROBLEM FOUR:

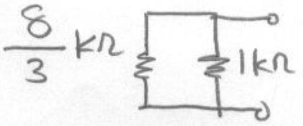
Find the Thevenin & Norton equivalent circuit of the circuit below with respect to terminals a and b:



R_{th}: Remove (short) independent voltage source



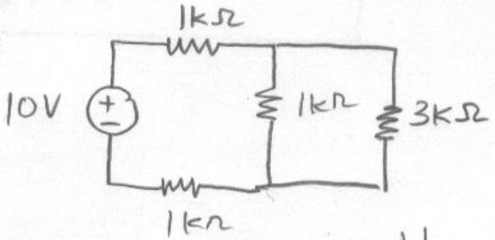


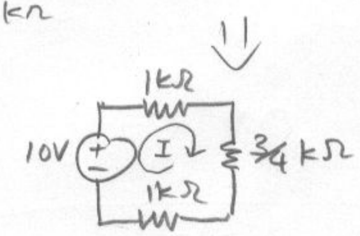


$$\frac{8}{3} // 1 = \frac{\frac{8}{3}\cdot 1}{\frac{8}{3}+\frac{3}{3}} = \boxed{\frac{8}{11} k\Omega = R_{th}}$$

$$\boxed{\frac{8}{11} k\Omega = R_N}$$

V_{th}: V_{oc}

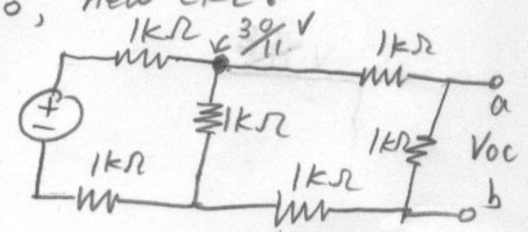




$$I = \frac{10}{2k\Omega + \frac{3}{4}k\Omega} = \frac{40}{11} mA$$

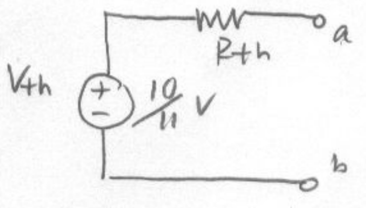
$$\left(\frac{40}{11} mA\right)\left(\frac{3}{4} k\Omega\right) = \frac{30}{11} V$$

So, new ckt:



$$V_{oc} = \frac{30}{11} / 3 = \frac{10}{11} V$$

$$\boxed{V_{th} = \frac{10}{11} V}$$



← Thevenin

$$\boxed{I_N = \frac{V_{th}}{R_{th}} = \frac{10}{8} = \frac{5}{4} A}$$

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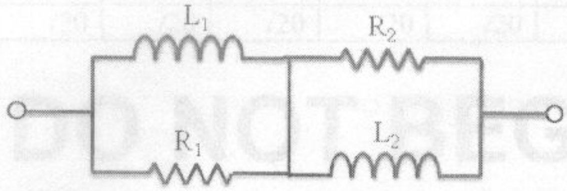
PROBLEM FIVE:

Find Z_{eq} for this circuit:



$$Z_{eq} = j\omega L_1 /\!/ R_1 + R_2 /\!/ j\omega L_2$$

$$Z_{eq} = \frac{j\omega L_1 \cdot R_1}{j\omega L_1 + R_1} + \frac{j\omega L_2 \cdot R_2}{j\omega L_2 + R_2} \ \Omega$$