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EE 40

Midterm 2

October 17, 2002

PLEASE WRITE YOUR NAME ON EACH ATTACHED PAGE

PLEASE SHOW YOUR WORK TO RECEIVE PARTIAL CREDIT

Problem 1: 10 Points Possible ______

Problem 2: 5 Points Possible ______

Problem 3: 15 Points Possible ______

Problem 4: 10 Points Possible ______

Problem 5: 10 Points Possible ______

Problem 6: 15 Points Possible ______

Problem 7: 15 Points Possible ______

Problem 8: 5 Points Possible ______

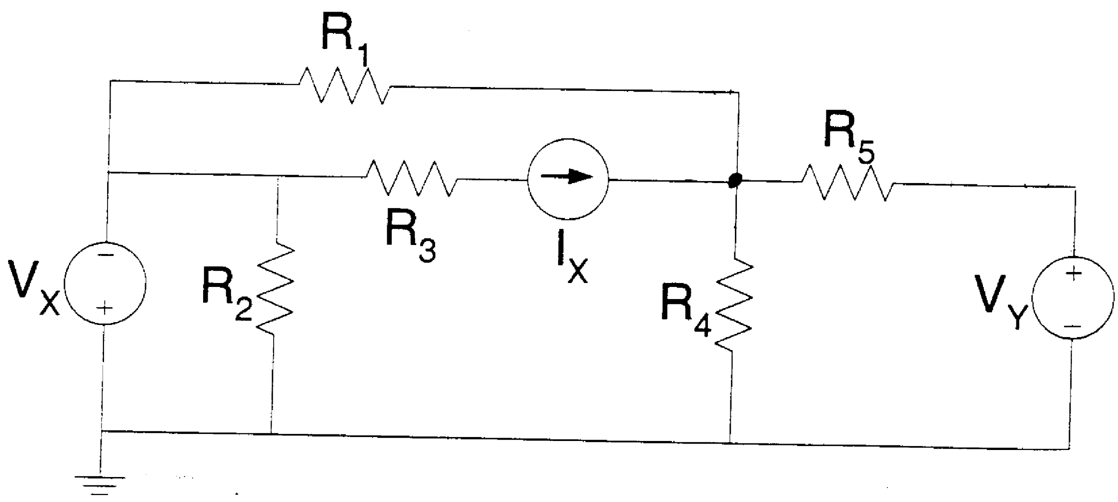
Problem 9: 15 Points Possible ______

Problem 10: 10 Points Possible ______

TOTAL: 110 Points Possible________

Problem 1: 10 Points Possible

Perform nodal analysis on the circuit below. This means write a KCL equation for each node with unknown voltage. DO NOT SIMPLIFY the circuit. DO NOT SOLVE the KCL equations

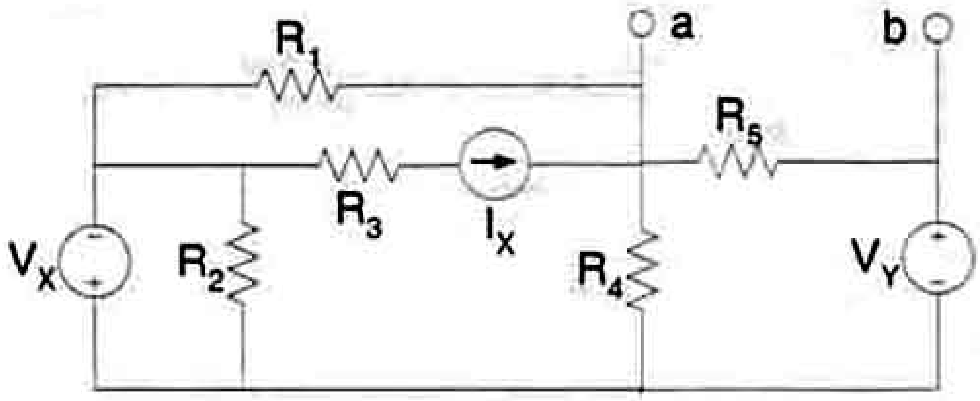


Problem 2: 5 Points Possible

In nodal analysis, when is a supernode needed? Why is a supernode needed?

<u>Problem 3</u>: 15 Points Possible

Revisiting the circuit from Problem 1,



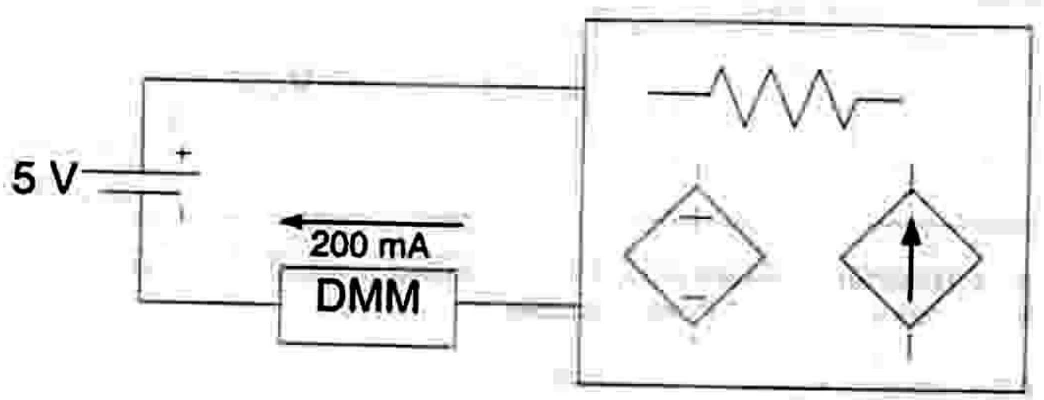
a) Find the Thevenin equivalent voltage V_T with respect to a and b. Express V_T in terms of node voltages. (5 Points Possible)

b) Find the Thevenin equivalent resistance R_T. DO NOT INCLUDE || symbol in final answer; write full mathematical expression. (10 Points Possible)

Problem 4: 10 Points Possible

Suppose I have a black-box circuit (I can't see exactly what's inside) but I know it only contains resistors and linear dependent sources. The controlling voltages and currents for the dependent sources are also in the box.

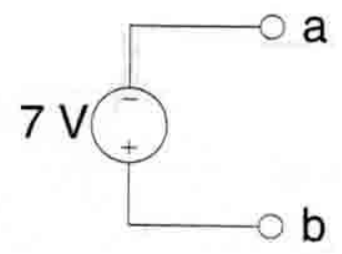
I perform one experiment: When I attach a 5 V battery as shown, I measure a 200 mA current in the direction shown. The internal resistance of the battery is 4 Ω and the internal resistance of the DMM is 1 Ω.

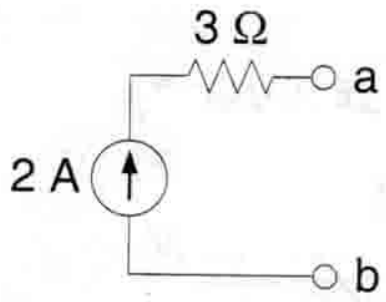


Can I find the Thevenin equivalent of the black-box circuit with this information? If yes, find the Thevenin equivalent. If no, explain why not.

<u>Problem 5</u>: 10 Points Possible

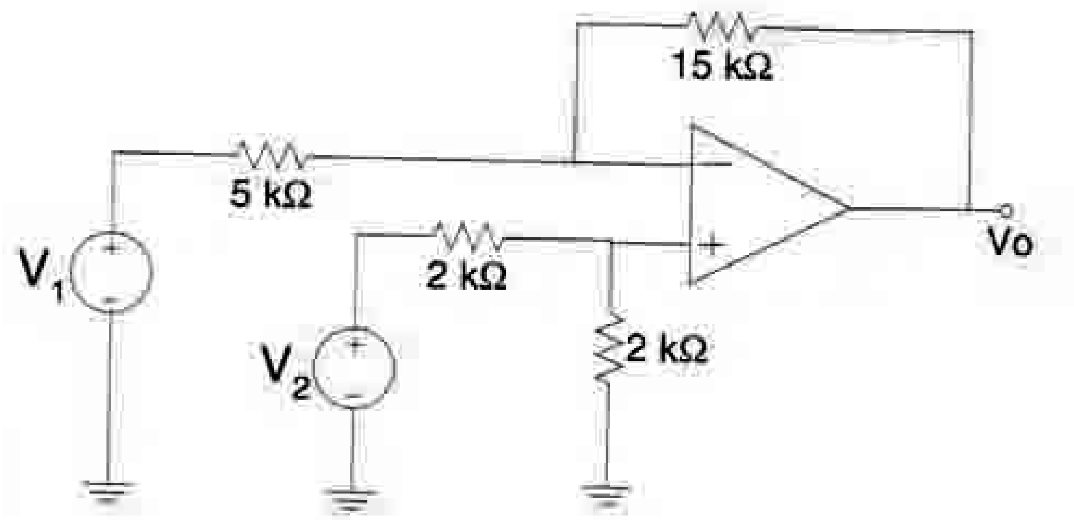
Find the Thevenin and Norton equivalents (if possible) for the following circuits:
(3 Points Possible for each Thevenin, 2 points Possible for each Norton)





Problem 6: 15 Points Possible

For the ideal operational amplifier circuit below, find V_0 in terms of V_1 and V_2. Assume that the operational amplifier is operating linearly (ignore the rails).



<u>Problem 7</u>: 15 Points Possible

Design an operational amplifier circuit that has an output voltage $V_0 = 3\ V_2 - 5\ V_1$. The input voltage sources V_1 and V_2 cannot be detached from ground, and each have their negative terminals at ground. Assume that your amplifier is operating linearly.

You will lose 5 points if you use more than one differential amplifier. If you are desperate, the instructor will "sell" you a hint for points.

<u>Problem 8</u>: 5 Points Possible

Suppose that we want to "clean up" a logic signal by transforming input voltages over 2.5V (the threshold voltage) to 5 V (logic 1) as output and voltages under 2.5 V to logic 0. Design a differential amplifier circuit that will perform this function. You many use one ideal differential amplifier; $R_i=\infty$, $R_0 = 0\ \Omega$ and gain $A= \infty$. You must specify the rail voltages for this amplifier.

<u>Problem 9</u>: 15 Points Possible

Now suppose that your differential amplifier circuit from Problem 8 has a finite gain A = 10,000. For the input $v_i(t)$ defined below, determine the propagation delay t_p, where t_p=time output reaches 50% of final value – time circuit reaches 50% of final value.

$$V_i(t) = \begin{cases} 0 & for \quad t < 0 \\ t & for \quad 0 \le t \le 5 \\ 5 & for \quad t > 5 \end{cases}$$ t in seconds, v_i in volts

Problem 10: 10 Points Possible

Find the time constant for the RC circuit below. DO NOT INCLUDE || symbol in final answer; write the full mathematical expression.