Signature: Sollution

DO NOT OPEN THIS BOOKLET UNTIL INSTRUCTED TO DO SO.

EXAM 2
ELEE 2335
October 31, 1987

INSTRUCTIONS:

1. Sign your name on the upper left of this page.

2. All work is to be done in the spaces provided in this booklet. Use the backs if necessary. Indicate clearly where your work and answers may be found. Enclose your final answers in a box. No credit will be given unless the necessary work is shown.

3. Show all of your units explicitly, both in your final answer and in your intermediate steps. Units in exam questions are placed within square brackets.

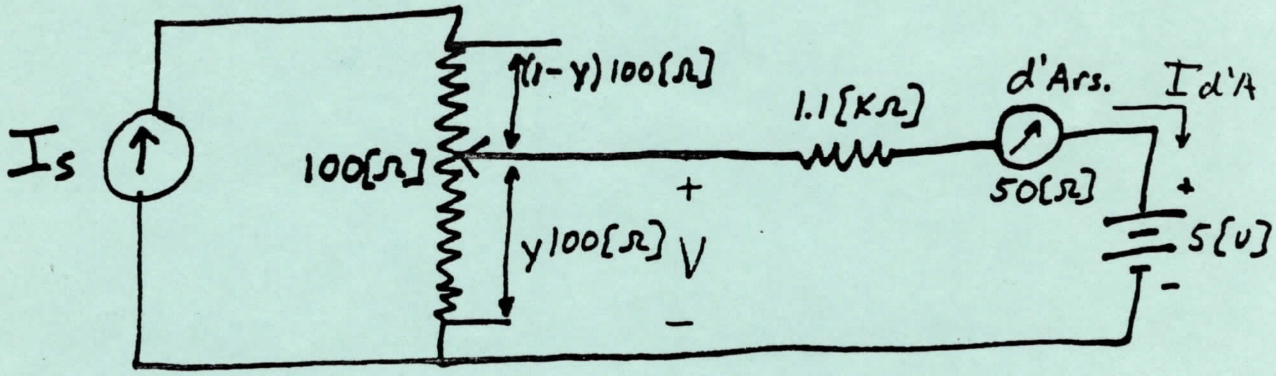
4. If your answers and work are not in ink, there will be no provision for changing your grade once the exam is returned to you. Do not use red ink.

5. The exam is closed book, except for one 8.5" x 11" crib sheet that must include your name and student number, and which must be turned in with your exam.

1. 15
2. 25
3. 15
4. 35
5. 20

110

1. (15 Points) The circuit shown is used to make a null measurement of the current source I_S. The slide wire potentiometer has a total resistance of 100[Ω].



a) A null measurement is obtained when the slide wire is positioned 2/3 of the way up the scale; that is, when y = 2/3. What is I_S in this case?

Solution

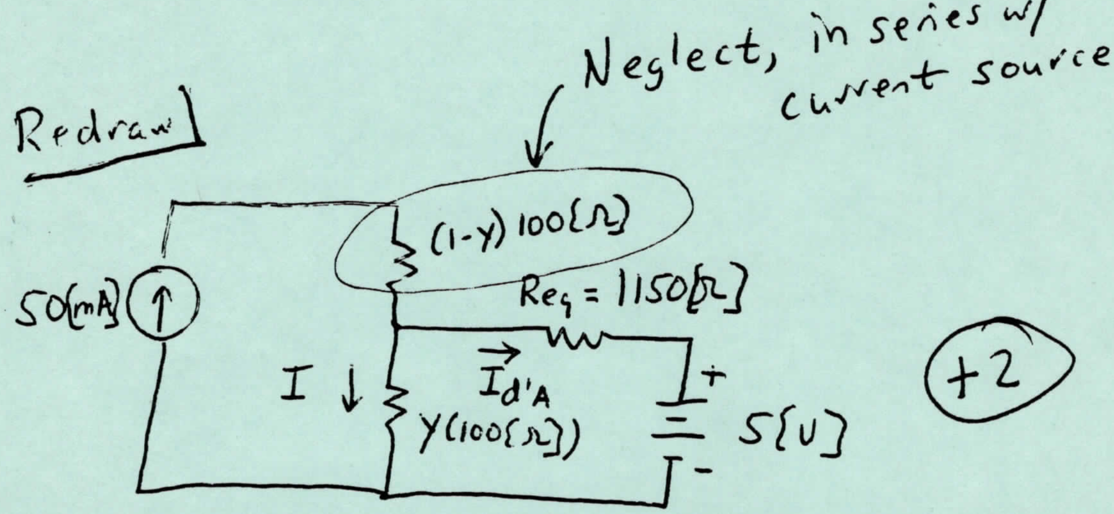
Null Measurement means $I_{d'A} = 0$ (+2)

$\Rightarrow V = 5[v]$ (+2)

$$I_s = \frac{5[v]}{\frac{2}{3}100[\Omega]} = 0.075[A]$$ (+1)

1. Continued. b) In a second case, it is given that I_S = 50[mA]. Find the current through the d'Arsonval meter movement as a function of y, the position of the slide wire.

Redraw



+2

$$50[mA] = I + I_{d'A}$$

$$I\,y\,100 = I_{d'A}\,1150 + 5\{V\}$$

Solve for $I_{d'A}$ +2

+2

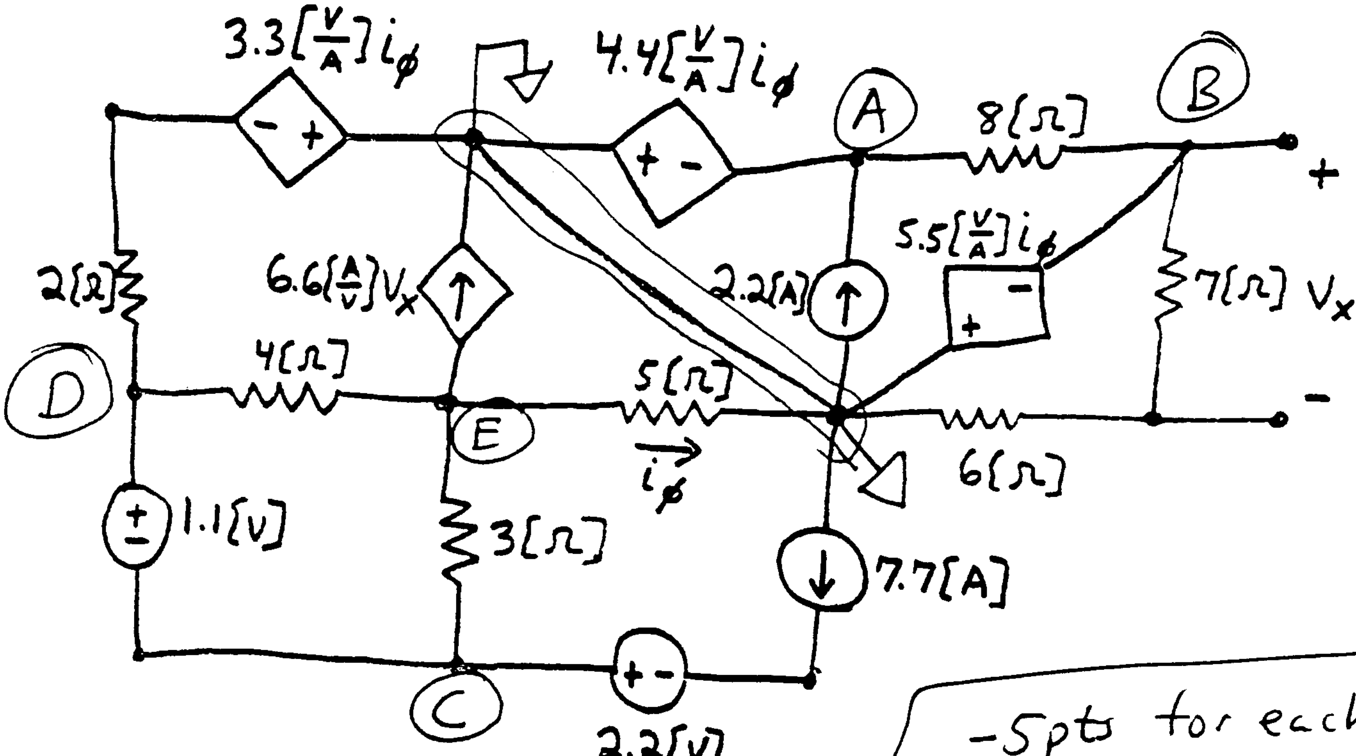
$$(50[mA] - I_{d'A})\,y\,100\{\Omega\} = I_{d'A}\,1150\{\Omega\} + 5\{V\} \quad +2$$

$$5[V]y - I_{d'A}\,y\,100\{\Omega\} = I_{d'A}\,1150[\Omega] + 5[V]$$

$$5\{V\}(y-1) = I_{d'A}(1150\{\Omega\} - 100\{\Omega\}y)$$

$$I_{d'A} = \frac{5\{V\}(y-1)}{1150\{\Omega\} + 100\{\Omega\}y} \quad +2$$

2. (25 Points) Write equations using the Node Voltage Method that could be used to solve the following circuit. Do not solve the equations. Be sure to write enough equations to be able to solve for all node voltages. Do not try to simplify the equations. Show your reference node and name your nodes.



-5pts for each wrong equ.
-5pts for each missing equ.

(A) $V_A = -4.4[\frac{V}{A}]i_\phi$

(B) $V_B = -5.5[\frac{V}{A}]i_\phi$

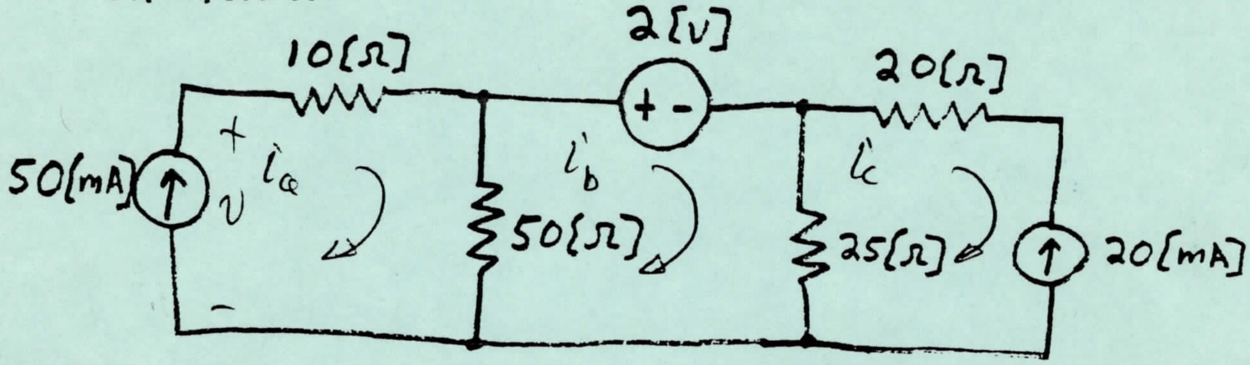
(C)+(D) $-7.7[A] + \frac{V_C - V_E}{3[\Omega]} + \frac{V_D - V_E}{4[\Omega]} + \frac{V_D + 3.3[\frac{V}{A}]i_\phi}{2[\Omega]} = 0$

(C)+(D) $V_D - V_C = 1.1[V]$

(E) $\frac{V_E - V_C}{3[\Omega]} + \frac{V_E - V_D}{4[\Omega]} + 6.6[\frac{A}{V}]V_x + i_\phi = 0$

(Dep 1) $i_\phi = \frac{V_E}{5[\Omega]}$ (Dep 2) $V_x = V_B \frac{7}{13}$

3. (15 Points) In the circuit below, what is the power delivered to the circuit by the 2[V] source? What is the power delivered to the circuit by the 50[mA] source?



MESH CURRENT METHOD

$i_a = 50$ [mA] +1

$i_c = -20$ [mA] +1

$50(i_b - i_a) + 25(i_b - i_c) + 2 = 0$ +4

$\Rightarrow i_b = 0$ +1

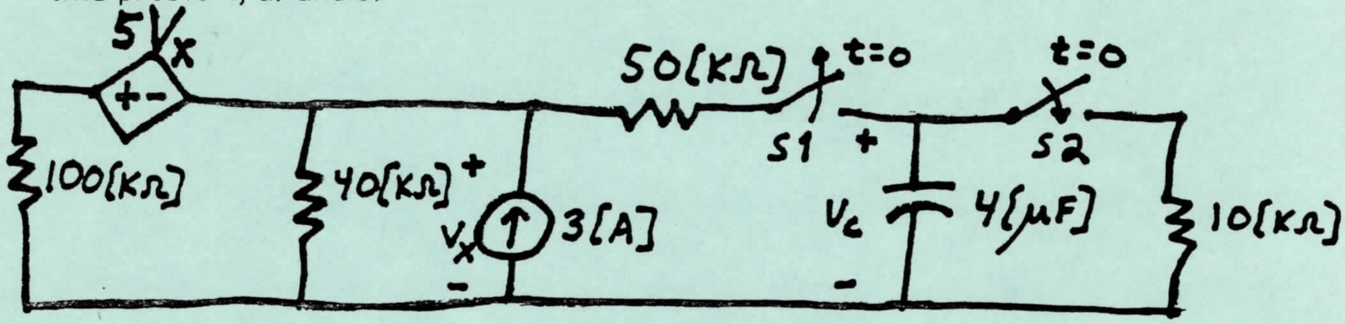
$P_{2V}^{absorbed} = P_{delivered} = 0$ +2

50 [mA] SOURCE:

$P^{delivered} = -P^{absorbed} = +vi = 150$ [mW] +3

$v_{50} = i_a(10) + (i_a - i_b^{\,0})(50) = 3$ [V] +3

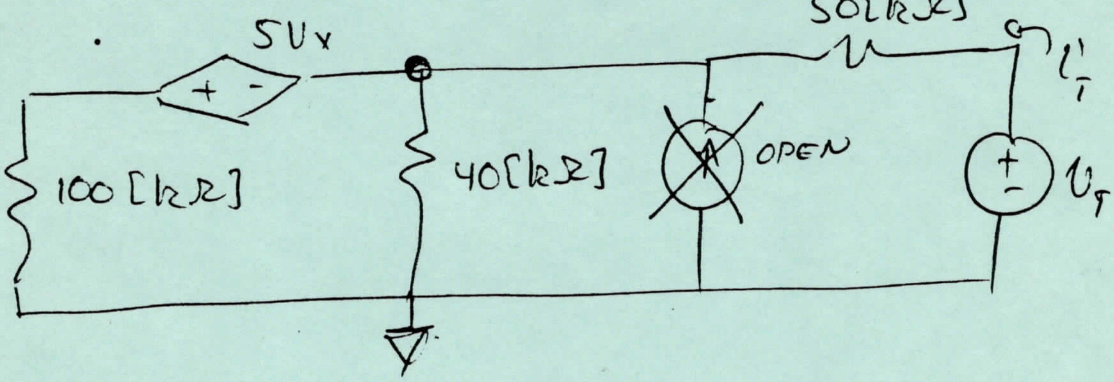
4. (35 Points) In the circuit shown, the switch S1 has been closed and the switch S2 has been open for a long time. Note that there are two parts to this problem, a) and b).



a) Find the Thevenin equivalent with respect to the capacitor terminals for this case. In other words, find the Thevenin equivalent with respect to the capacitor for t ≤ 0.

FIND R_{TH}:

t<0



$$\frac{v_X}{40k} + \frac{v_X + 5v_X}{100k} - i_T' = 0$$ +5

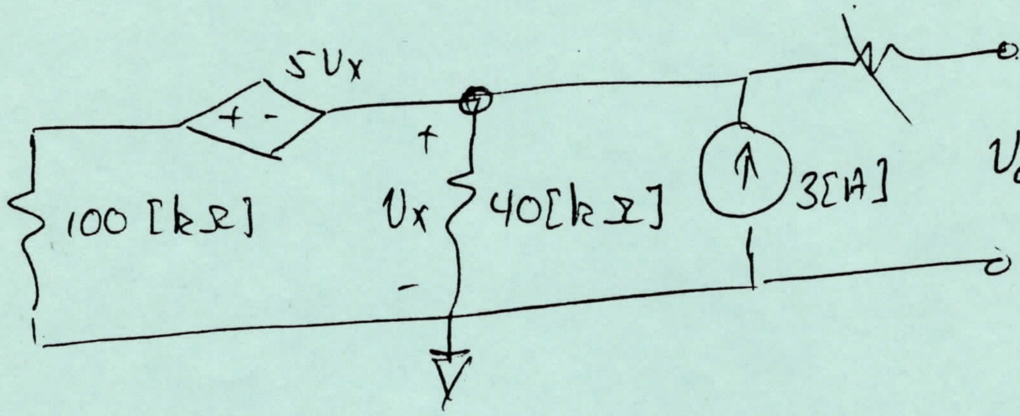
$$v_X - v_T + 50\times10^3\, i_T' = 0$$ +4

$$\Rightarrow \quad \frac{v_T}{i_T'} = \boxed{R_{TH} = 61.8\,[k\Omega]}$$ +4

ZD

Room for Extra Work

OPEN CIRCUIT VOLTAGE



$V_{oc} = V_x = V_{TH}$

$$\frac{V_x}{40k} - 3 + \frac{V_x + 5V_x}{100k} = 0$$

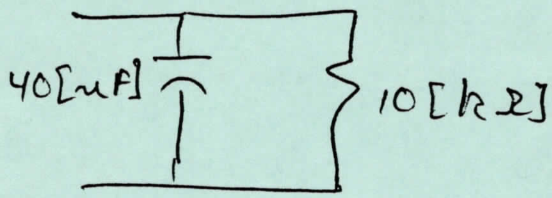
+10

$$\Rightarrow V_x = \boxed{V_{TH} = 35.\bar{3}\,[kV]}$$

+3

4. continued. b) At t = 0, S1 opens and S2 closes. Find $v_C(t)$ for $t \geq 0$.

$\underline{\underline{t > 0}}$



$V(0) = V_{TH}$ +3

$\tau = RC = (40 \times 10^{-6})(10 \times 10^{3}) = 0.04\,[s]$ +3

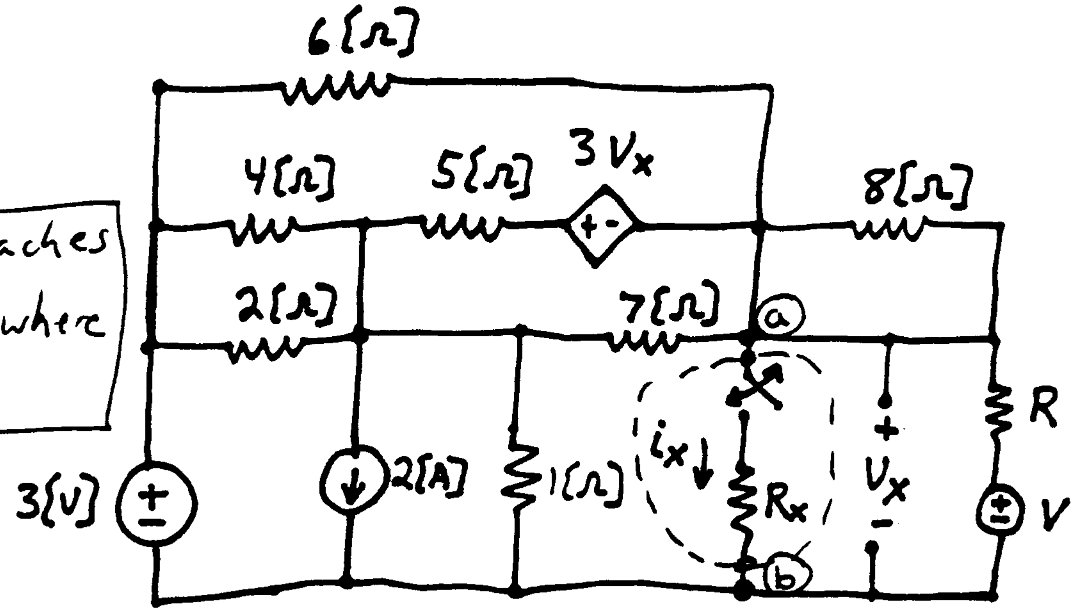
$$v_c(t) = 35.3 \times 10^{3}\, e^{-25t}$$ +3

Grading → for complete and accurate approach described = +10 points

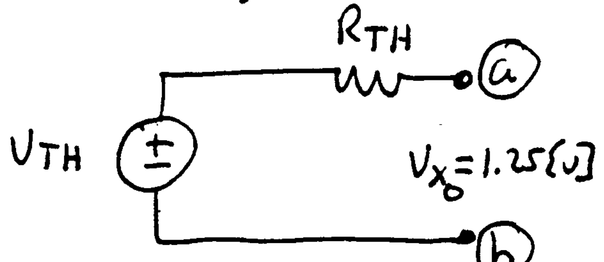
5. (20 Points) In this circuit, it has been found that with $R_X = 10[\Omega]$ and with the switch open, $V_X = 1.25[V]$. With $R_X = 10[\Omega]$ and with the switch closed, $V_X = 0.93[V]$. Assume that R_X can be changed. Find the current I_X that would result for each of the following values of R_X, with the switch closed:

$R_X = 9[\Omega]$,
$R_X = 8[\Omega]$,
$R_X = 7[\Omega]$, and
$R_X = 3[\Omega]$.

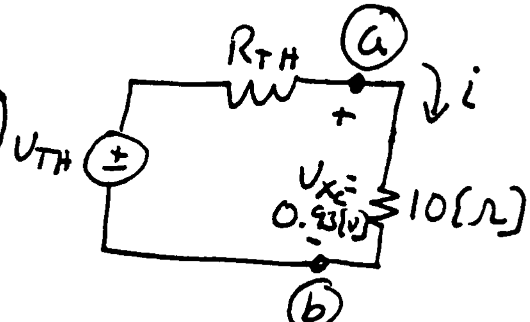
Other approaches with credit where appropriate



The circuit outside of the dotted line can be replaced by a Thev. equiv. ckt. Using that, we can draw



and



$V_{TH} = 1.25[V] \Rightarrow i = 0.093[A] = \dfrac{1.25 - 0.93[V]}{R_{TH}}$

$R_{TH} = 3.44[\Omega]$

for $R_x = 9[\Omega]$

$i_{x9} = \dfrac{1.25[V]}{9 + 3.44[\Omega]}$

$i_{x9} = 0.100[A]$

for $R_x = 8[\Omega]$

$i_{x8} = \dfrac{1.25[V]}{11.44[\Omega]}$

$i_{x8} = 0.109[A]$

for $R_x = 7[\Omega]$

$i_{x7} = \dfrac{1.25[V]}{10.44[\Omega]}$

$i_{x7} = 0.120[A]$

For $R_x = 3[\Omega]$

$i_{x3} = \dfrac{1.25[V]}{6.44[\Omega]}$

$i_{x3} = 0.194[A]$