Signature: Solution Key

DO NOT OPEN THIS BOOKLET UNTIL INSTRUCTED TO DO SO.

EXAM 1
ELEE 2335
September 26, 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.

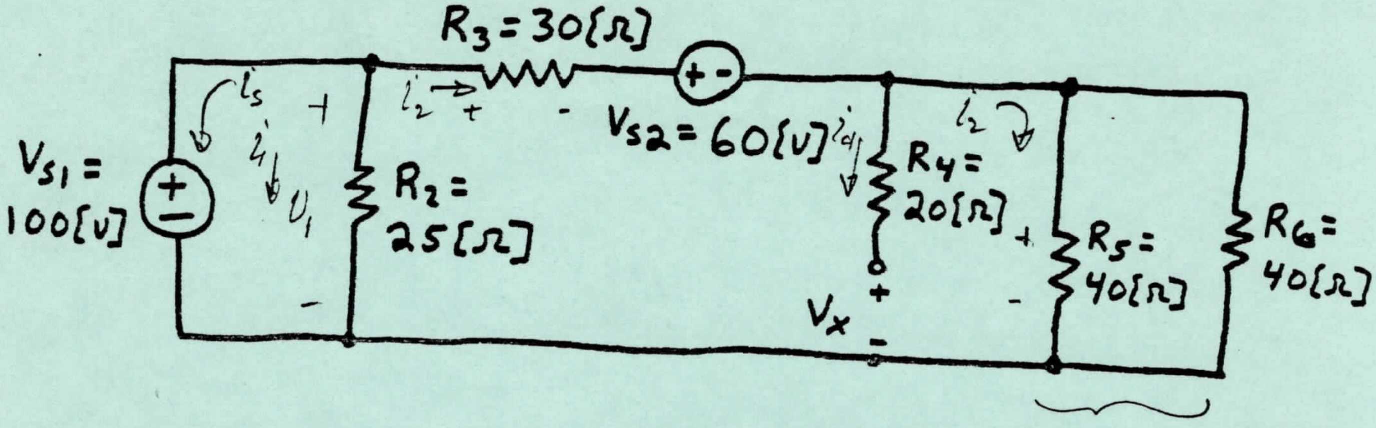
3. Show all of your units explicitly, both in your final answer and in your intermediate steps. Units in exam questions are placed within square brackets.

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. 12
4. 15
5. 10
6. 18
7. 5

1. (15 Points) Using the circuit below, find v_x.



$v_1 = 100\,[V]$ $\quad i_4 = 0 \Rightarrow v_{R4} = 0$ $\quad +3$

$v_1 - v_x - 60 - i_2 R_3 = 0$ $\quad +4$

$v_1 - i_2 R_{eq} - 60 - i_2 R_3 = 0$ $\quad +4$

$i_2 (R_{eq} + R_3) = v_1 - 60 = 40\,[V]$

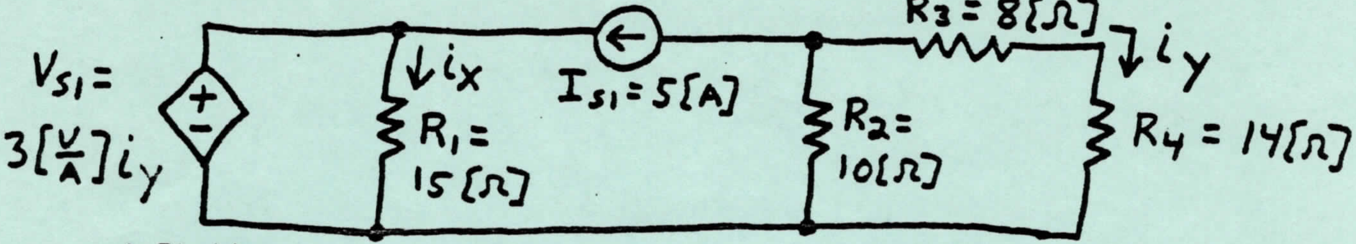
$\therefore\ i_2 = \frac{40}{50} = \frac{4}{5}\,[A]$

$\Rightarrow\ v_x = v_1 - 60 - \frac{4}{5}(30)$

$v_x = 16\,[V]$

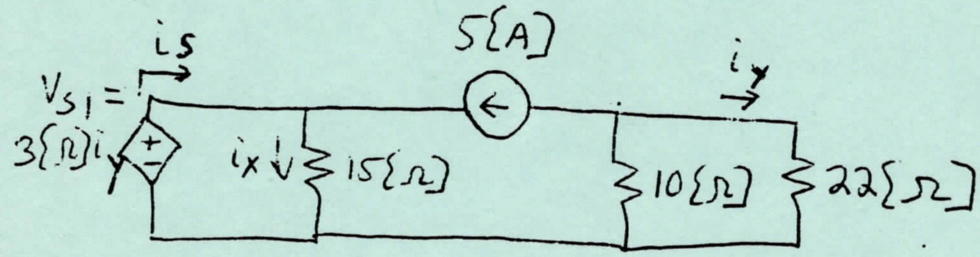
+3 (UNITS +1)

2. (25 Points) Use the circuit below for both parts of this problem.



a) Find i_x.

Redraw



(+2)

by current divider rule → $i_y = -5\{A\} \frac{10}{32} = -1.56[A]$ (+5)

$V_{S1} = 3\{\Omega\}(-1.56)\{A\} = -4.69[V]$ (+5)

(+3) $i_x = \frac{V_{S1}}{15[\Omega]} = \frac{-4.69[V]}{15[\Omega]} = \boxed{-0.313\{A\}}$

2. (continued) b) Find the energy provided by the source v_{s1} in 3[ms].

First, Find power provided.

$$P_{V_{s1}} = V_{s1} i_s = -4.69[V] i_s$$ (+5)

KCL → $i_s = i_x - 5[A]$

$i_s = -5.313[A]$

$$P_{V_{s1}} = 24.92[W]$$ (+3)

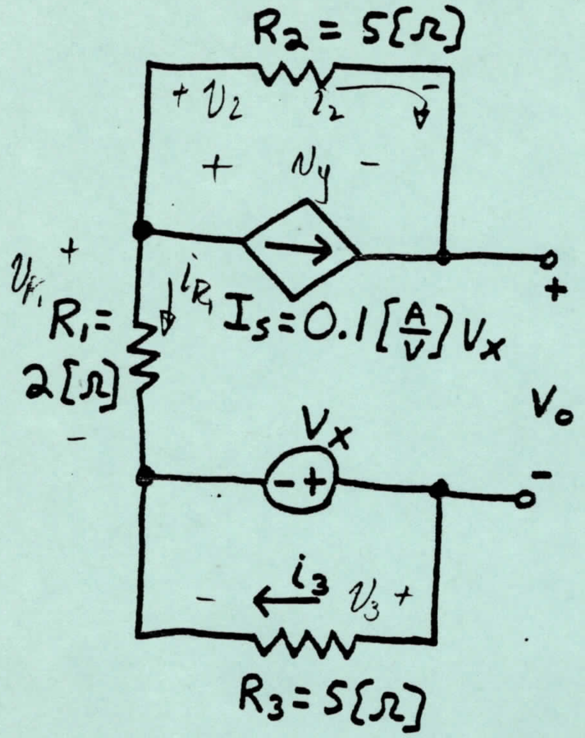
in 3 [ms]

$$W = 24.92 \frac{[\text{joules}]}{[\text{sec}]} 0.003[\text{sec}]$$

W = 75 [mjoules] (+2)

−5 major error
−2 math error
−3 no units

3. (12 Points) In the circuit below, it is given that $i_3 = 3[A]$. Find v_o.



NOTE: $i'_{R_1} = 0$ +2

$\Rightarrow v_{R_1} = 0$ +2

$\therefore \; v_o = -v_y - v_x + v_{R_1}$

$v_o = -15[V] - (-7.5[V])$

$v_o = -7.5[V]$ +2

(UNITS +1)

$i_3 = 3[A] \Rightarrow v_x = v_3 = 3[A] \cdot 5[\Omega] = 15[V]$ +2

$I_s = 0.1\, v_x = 1.5[A]$ (+1)

$-I_s - i'_2 = 0 \Rightarrow i'_2 = -i'_s = -1.5[A]$ +2

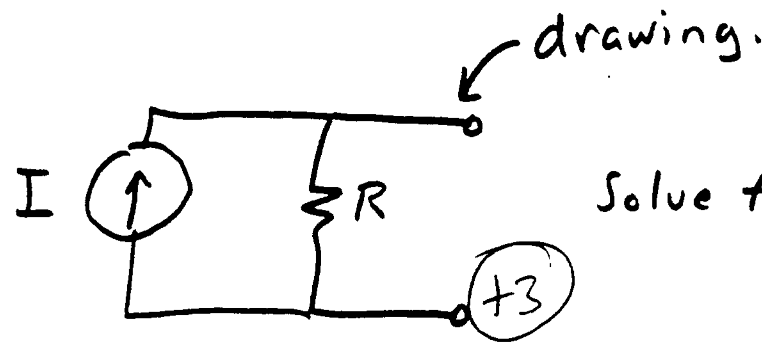
$\therefore \; v_y = v_2 = -1.5[A] \cdot 5[\Omega] = -7.5[V]$ +2

NOTE: $i'_2 + i'_s + i'_{R_1} = 0$

$\Rightarrow i'_{R_1} = -i'_2 - i'_s = 0$

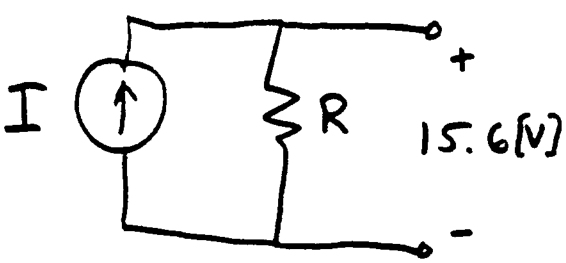
4. (15 Points) A practical current source is made up of an ideal current source in parallel with a resistor. Suppose that for a particular practical current source, the voltage with the terminals open was measured to be 15.6[V], and the voltage across the same source was 13.7[V] when connected to a 1[Ω] resistor. Find the values for the equivalent circuit for this practical source, and draw it.

Practical Source:

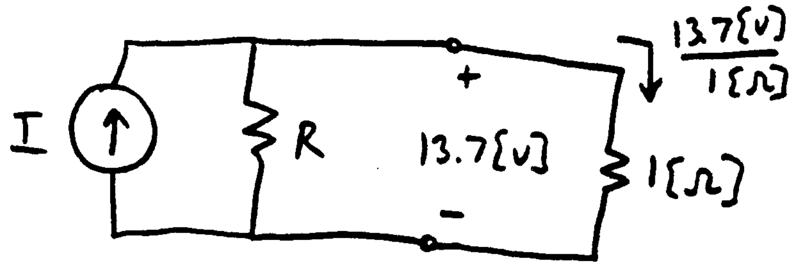


Solve for R and I

(+3)



$I R = 15.6[V]$ (+4)



$13.7[A] = I\left(\frac{R}{R+1}\right)$ (+4)

2 equ.s → 2 unks.: Solve →

$13.7 R + 13.7 = \left(\frac{15.6}{R}\right) R = 15.6$

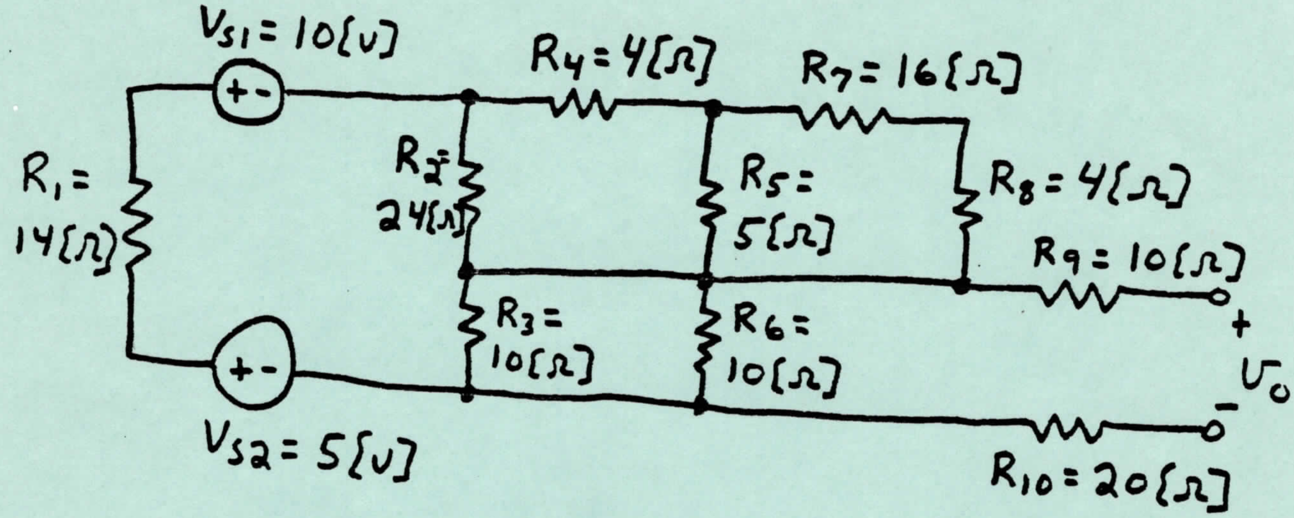
$R = \frac{15.6 - 13.7}{13.7}[\Omega] = 0.139[\Omega]$

$I = \frac{15.6[V]}{0.139[\Omega]}$

$I = 112[A]$

(+4)

5. (10 Points) Using the circuit below, find v_o.



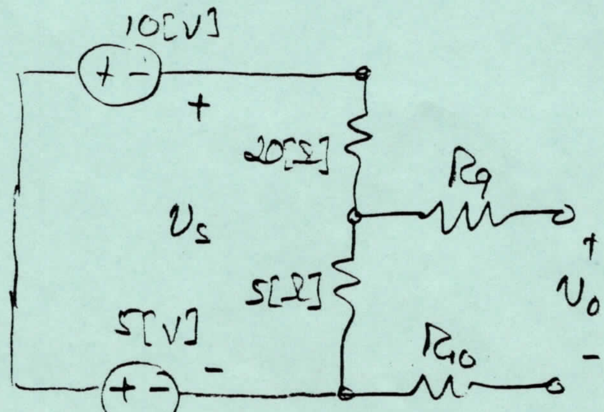
THIS IS A VOLTAGE DIVIDER :

(1) $R_8 + R_7 = 20[\Omega] \parallel R_5 = 4[\Omega] + R_4 = 8[\Omega] \parallel R_2$ (+2½)

$= 6[\Omega] + R_1 = 20[\Omega]$

(2) $R_6 \parallel R_{10} = 5[\Omega]$ (+½)

SO WE HAVE



$v_s = -5[V]$ (+1)

(+1)

$v_{R_9} = v_{R_{10}} \equiv 0$

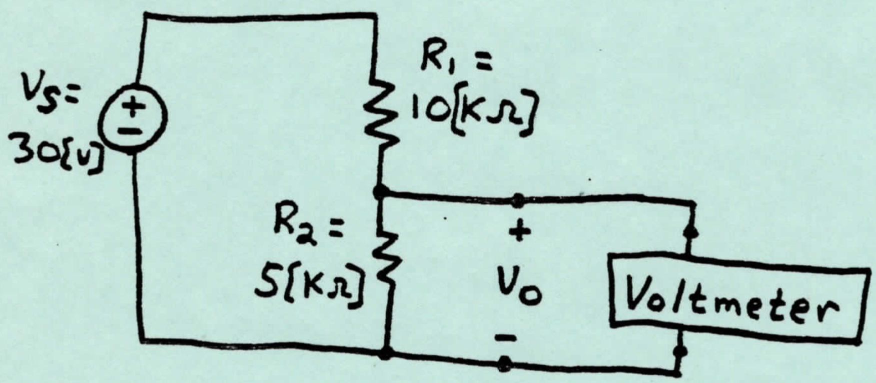
since $i = 0$

(+3)

$\therefore \; v_o = \dfrac{-5[V] \cdot 5[\Omega]}{25[\Omega]} = -1[V]$

UNITS: (+2)

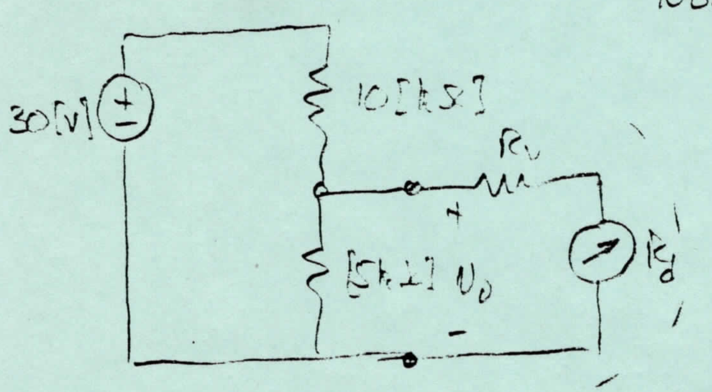
6. (18 Points) You have available voltmeters with sensitivities of 1[kΩ/V], 2[kΩ/V], 10[kΩ/V], 20[kΩ/V] and 100[kΩ/V]. If the meter is to be operated at 10[V] fullscale, what is the minimum sensitivity meter you can use so that the error in reading v_o is no greater than 5%? The circuit being measured is shown below.



OPEN CKT VOLTAGE : $V_o = 30[V] \cdot \frac{5[k\Omega]}{15[k\Omega]} = 10[V]$ (+1)

∴ 5% error ⇒ $V_o \geq 9.5[V]$ +4

WITH METER :



$R_m = R_v + R_d$

Now, $V_o = 30[V] \cdot \frac{R_{eq}}{10[k\Omega] + R_{eq}} = 9.5[V]$ (+6)

∴ $R_{eq} = \frac{R_m \cdot 5[k\Omega]}{5[k\Omega] + R_m} = 4.634[k\Omega]$ (+5)

∴ $R_m = 63.31 [k\Omega]$ +1

METER SENSITIVITY $S = \frac{R_m}{V_{fs}}$ +3

$= 6.33 \frac{[k\Omega]}{[V]}$ (+1)

∴ 10[kΩ/V] meter is required

7. (5 Points) A student taking a practical lab exam makes an error reading a voltage with his d'Arsonval based voltmeter. The student argues that this was caused by the battery in his meter having run down. Qualitatively, what portion of his error was likely to be due to this problem? Assume the error in his reading was about 15%.

None of it was due to his battery running down. A d'Arsonval based voltmeter does not use a battery.