Signature: Solution Key

	Sect.	Course
High -	92	93
Low -	23	17
Ave -	59.1	55.4
STD		19.08

DO NOT OPEN THIS BOOKLET UNTIL INSTRUCTED TO DO SO.

EXAM 1
ELEE 2335
February 21, 1987

INSTRUCTIONS:

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

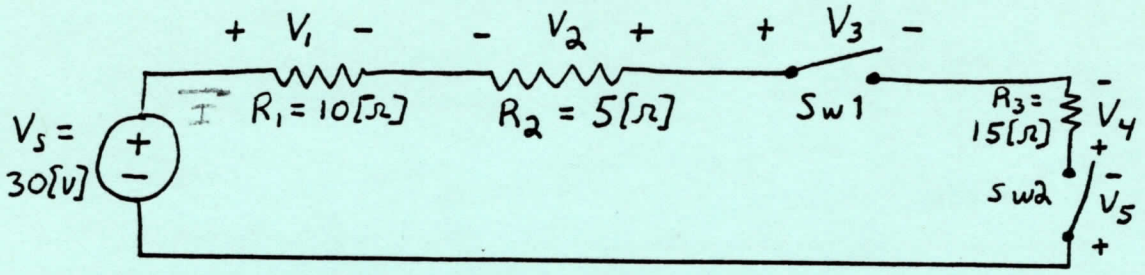
2. All work is to be done in the spaces provided in this booklet. Use the backs if necessary. Indicate clearly where your work and answers may be found. Enclose your final answers in a box. No credit will be given unless the necessary work is shown.

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.

1.	10
2.	10
3.	25
4.	15
5.	20
6.	20

1. (10 Points) Use the circuit below for both parts of this problem.



a) Determine the values of the voltages V_1, V_2, V_3, V_4 and V_5, when the switches Sw1 and Sw2 are closed.

$I = \frac{V_S}{R_{TOTAL}} = \frac{30}{30} = 1[A]$

$\therefore V_1 = IR_1 = 10[V]$

$V_2 = -IR_2 = -5[V]$

$V_3 = I \cdot 0 = 0[V]$

$V_4 = -IR_3 = -15[V]$

$V_5 = I \times 0 = 0[V]$

b) Determine the values of the voltages V_1, V_2, V_3, V_4 and V_5, when switch Sw1 is open and switch Sw2 is closed.

WHEN S_{W1} IS OPEN, $I = 0$

$\therefore V_1 = 0 \times R_1 = 0[V]$

$V_2 = 0 \times R_2 = 0[V]$

$V_3 = 0 \times \infty \Rightarrow$ INDETERMINANT - MUST USE VOLTAGE LAW

$V_4 = 0 \times 15 = 0[V]$

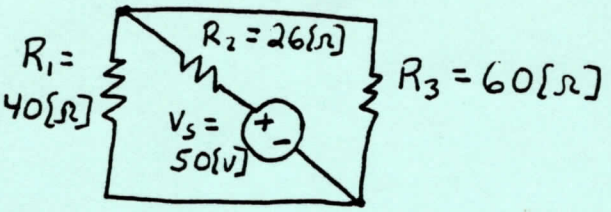
$V_5 = 0 \times 0 = 0[V]$

FOR V_3, $V_S - V_1 + V_2 - V_3 + V_4 + V_5 = 0$

HENCE $30 - 0 + 0 - V_3 + 0 + 0 = 0$

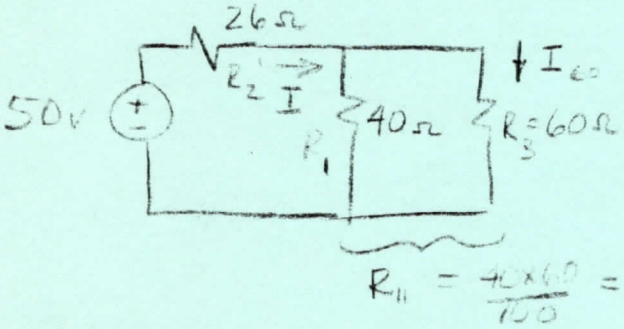
$V_3 = 30[V]$

2. (10 Points) Use the circuit below for both parts of this problem.



a) Determine the power provided by the voltage source.

REDRAW NETWORK



$R_{11} = \frac{40 \times 60}{100} = 24\Omega$

$I = \frac{50}{26+24} = \frac{50}{50} = 1A$

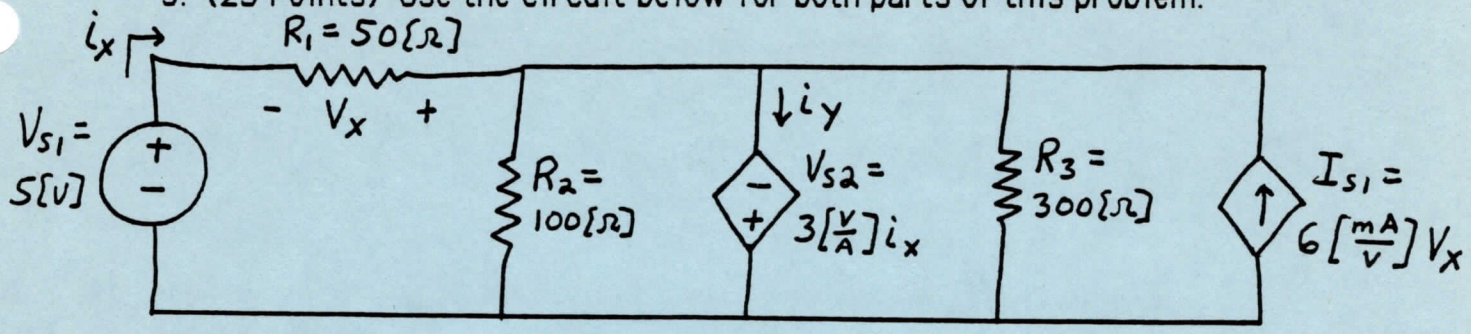
$P = 50 \times 1 = \underline{50[W]}$

b) Determine the power absorbed by the 60[Ω] resistor.

$I_{60} = I \times \frac{40}{100} = 1 \times .4 = .4[A]$

$P_{60} = I_{60}^2 R_3 = .16 \times 60 = \underline{9.6 \text{ watts}}$

3. (25 Points) Use the circuit below for both parts of this problem.



a) Find i_x and i_y.

Take KVL around loop including V_{S1}, R_1 and V_{S2}.

$$V_{S1} - i_x R_1 + V_{S2} = 0 \quad \text{(5pts)}$$

$$5[V] - i_x 50 + 3 i_x = 0$$

$$5[V] = 47[\Omega] i_x$$

$$\boxed{i_x = 0.106[A]} \quad \text{(3pts)}$$

Grading Scheme.
-5pts for sign error in KVL, KCL
-2pts. for other sign error
-2pts math error

Then, taking KCL

$$-i_x - \frac{V_{S2}}{100} - \frac{V_{S2}}{300} - I_{S1} + i_y = 0 \quad \text{(5pts)}$$

$$i_y = 0.106[A] + \frac{3[\Omega]\,0.106[A]}{100[\Omega]} + \frac{3[\Omega]\,0.106[A]}{300[\Omega]} + 6[\frac{mA}{V}] V_x$$

$$V_x = -i_x R_1 = -.106[A]\,50[\Omega] = -5.32[V] \quad \text{(4pts)}$$

$$i_y = 0.106[A] + 0.00318[A] + 0.00106[A] - 0.03192[A]$$

$$\boxed{i_y = 0.078[A]} \quad \text{(3pts)}$$

3. (continued) b) Find the power dissipated in resistor R_1.

$$P_{R1} = i_x^2 R_1 = (.106[A])^2 \, 50[\Omega] = \boxed{0.562[W]}$$

5 pts

4. (15 Points) A voltmeter with a 200[V] fullscale has a d'Arsonval meter movement with a 1[mA], 100[mV] sensitivity. It is desired to measure a voltage between 200[V] and 300[V]. It has been suggested that a resistor be connected externally to one of the voltmeter leads to make the meter read 300[V] fullscale. What value resistor do you suggest?

The original voltmeter has a total resistance of

$$\frac{200\,[V]}{1\,[mA]} = 200K[\Omega]$$

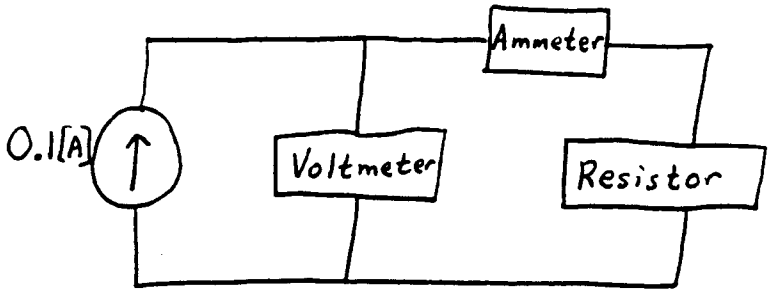
The total resistance required for a 300 V fullscale reading using the same movement is

$$\frac{300\,[V]}{1\,[mA]} = 300K\,[\Omega]$$

Therefore $R_{(external)} = 300K - 200K = \underline{100K[\Omega]}$

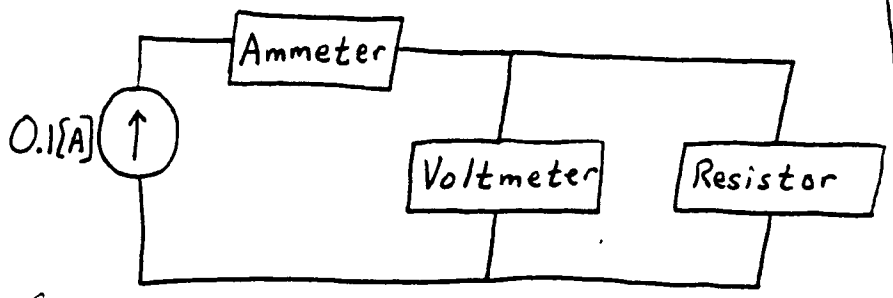
5. (20 Points) The diagrams below show two methods of measuring an unknown resistance with a voltmeter and an ammeter. In each case, the resistance measurement is calculated from the ratio of the voltage measured to the current measured. If the resistor is 1[Ω], which method gives the most accurate reading? Defend your answer.

The meters are d'Arsonval types with movements rated at 25[mV] and 1[mA]. The voltmeter is designed to read 500[mV] full scale, and the ammeter to read 100[mA] full scale.



Method 1

No credit if no explanation or invalid explanation



Method 2

(+4) [Voltmeter resistance = $\frac{500[mV]}{1[mA]} = 500[\Omega]$

(+4) [Ammeter resistance = $\frac{25[mV]}{100[mA]} = 0.25[\Omega]$

(+4) Method 1 measures Ammeter Resistance in Series with Resistor, Measures 1.25[Ω]

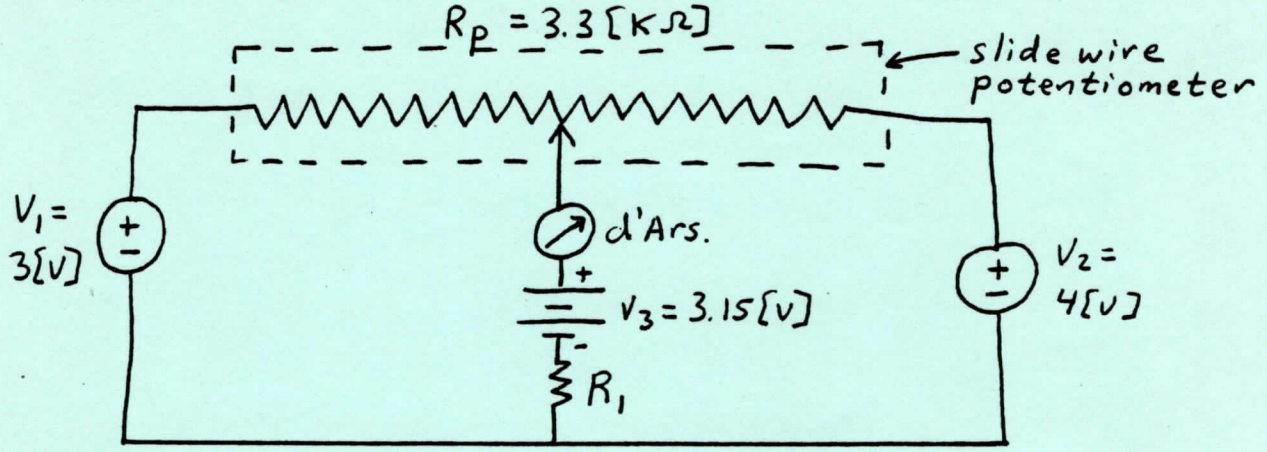
$\%\ Error = 100 \times \frac{1 - 1.25}{1} = -25\%$

(+4) Method 2 measures Voltmeter resistance in parallel with resistor, Measures $\frac{(500)(1)[\Omega]}{501} = .998[\Omega]$

$\%\ Error = 100 \times \frac{1 - .998}{1} = 0.2\%$

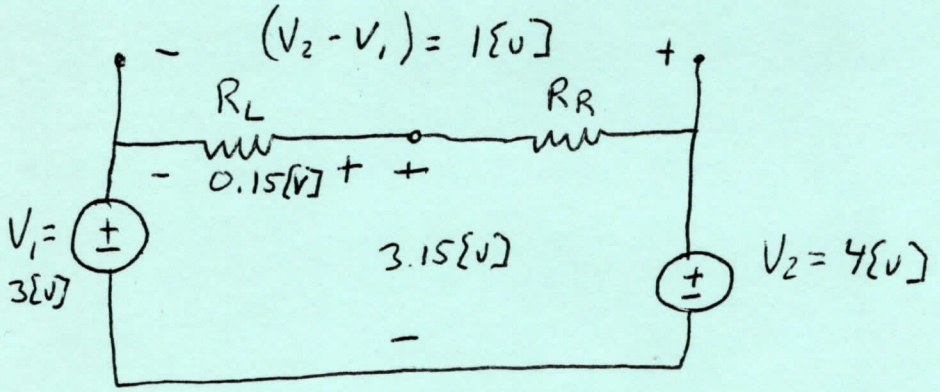
(+4) Method 2 is better

6. (20 Points) In the circuit below the slide wire potentiometer is made up of a metal bar with a total resistance of 3.3[kΩ], with a slide wire that can be moved to the left or to the right across it. The slide wire is moved until the d'Arsonval reads zero. The d'Arsonval is rated at 50[mV], 1[mA].



a) What is the resistance of the metal bar to the right of the slide wire?

Redraw circuit



+3

V.D.R. $\quad 0.15[V] = 1[V]\dfrac{R_L}{R_L + R_R}$

$$R_L + R_R = 3.3\,[K\Omega]$$

$$\frac{0.15}{1} = \frac{R_L}{3.3\,[K\Omega]} \Rightarrow R_L = 495\,[\Omega]$$

+3

$$\boxed{R_R = 3.3[K\Omega] - R_L = 2.805\,[K\Omega]}$$

+2

6. (continued) b) What is the reason for including resistor R_1 in this circuit?

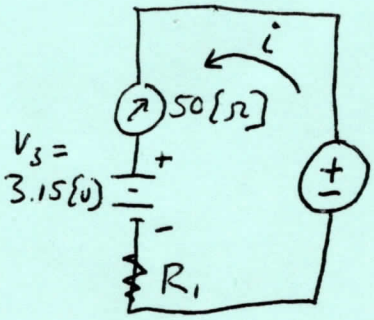
This resistor will limit the current flow thru the d'Arsonval (or voltage drop across d'Arsonval) to protect the d'Arsonval meter movement from damage. (+4)

c) What is the lowest value for R_1 that can be used?

The largest possible current thru d'Ars. occurs with slide pot at far right, since that results in the largest voltage drop across the d'Ars.

Redraw.

$$\text{d'Ars equiv. resistance} = \frac{50[\text{mV}]}{1[\text{mA}]} = 50[\Omega]$$



(+3)

Solve for minimum R_1:

KVL:

$$V_2 = 50[\Omega]\, i + V_3 + i R_1$$

$i = 1[\text{mA}]$ (current limit)

$$4[\text{V}] - 3.15[\text{V}] = 1[\text{mA}]\,(50[\Omega] + R_1) \quad (+3)$$

$$\frac{.85}{.001}[\Omega] = (50 + R_1)[\Omega] \Rightarrow \boxed{R_1 = 800[\Omega]} \quad (+2)$$