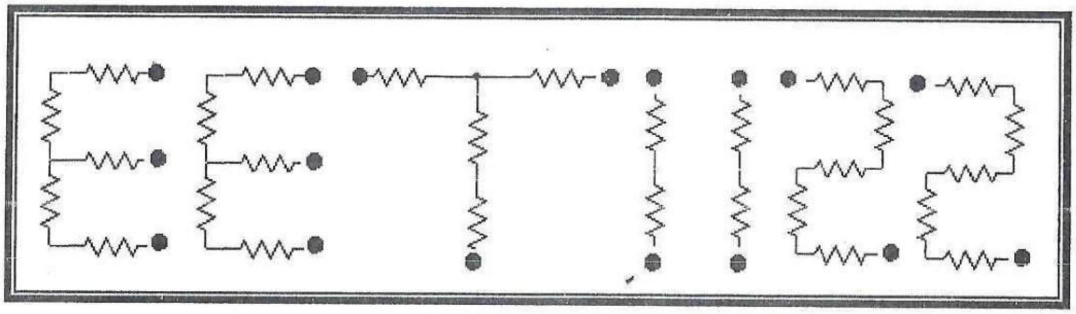
# NEW YORK CITY COLLEGE OF TECHNOLOGY
# OF THE CITY UNIVERSITY OF NEW YORK

## ELECTRICAL and TELECOMMUNICATIONS ENGINEERING TECHNOLOGY DEPARTMENT

## EET 1122
## CIRCUITS ANALYSIS I
## LABORATORY MANUAL

**Revised by Prof. M. Kouar Spring 2008**



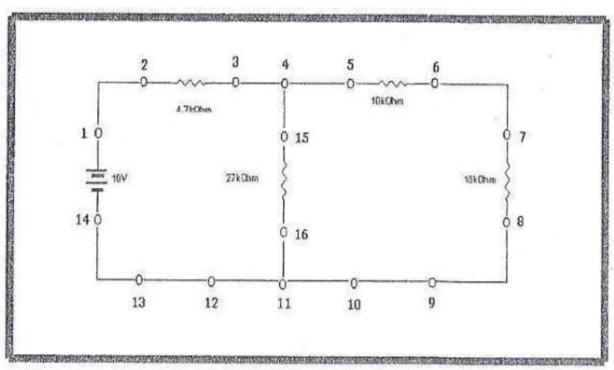
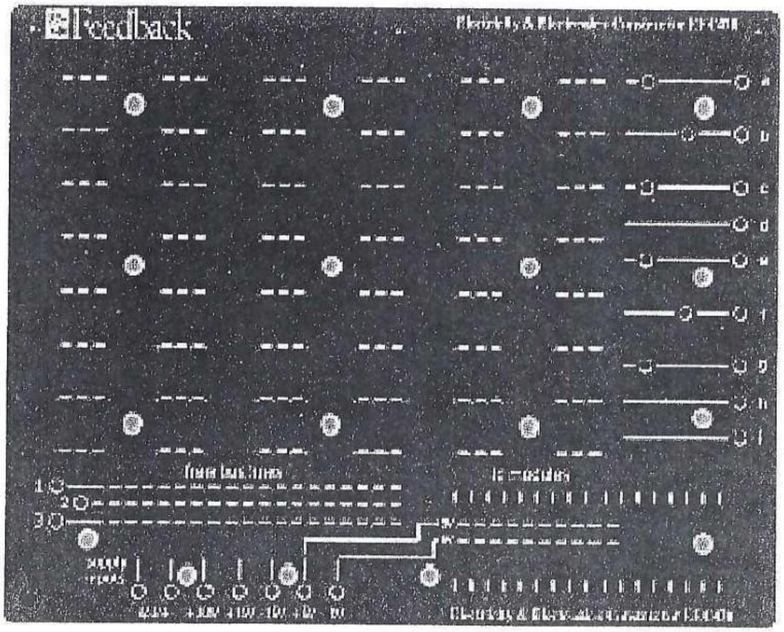
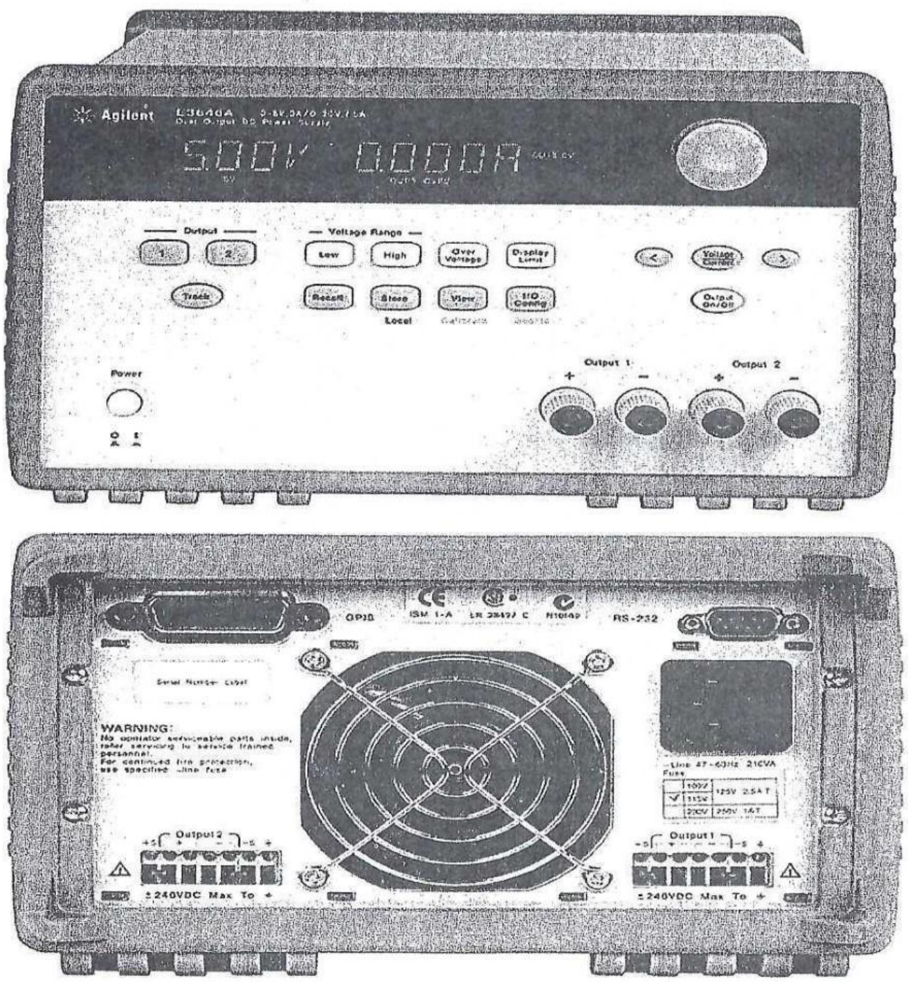


TABLE OF CONTENTS PAGE

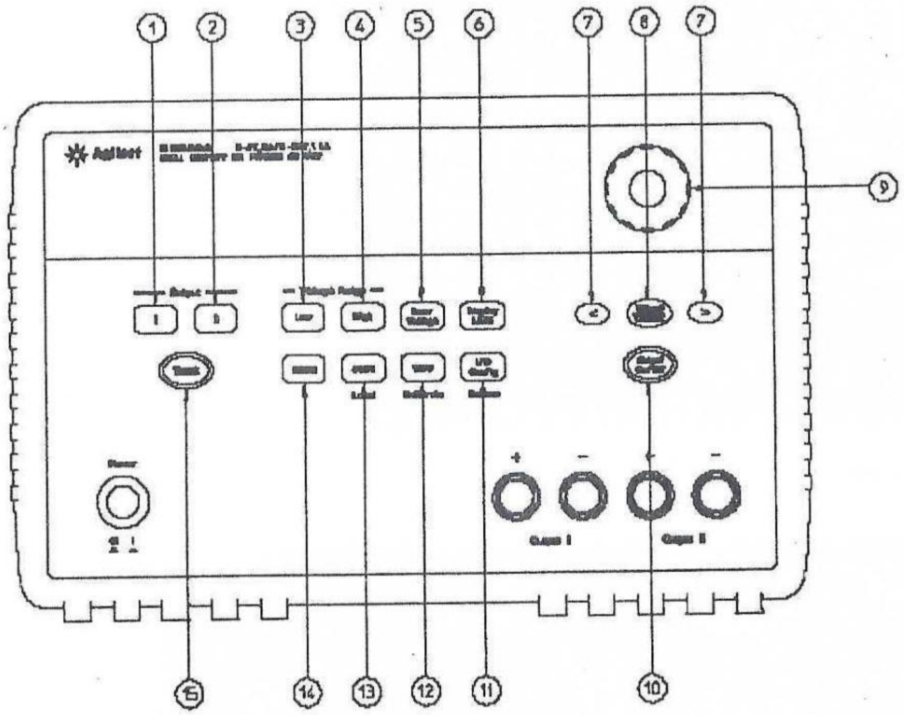
**Feedback board used for the experiments**




**Agilent DC Power Supply**



## The Front Panel at a Glance



1 Output1 selection Key
2 Output2 selection Key
3 Low voltage range selection Key
4 High voltage range selection Key
5 Overvoltage protection Key
6 Display limit Key
7 Resolution selection Keys
8 Voltage / Current adjust selection Key
9 Knob
10 Output On / Off Key
11 I/O Configuration Menu / Secure Key
12 View Menu / Calibrate Key
13 State Storage Menu / Local Key
14 Stored state Recall/Reset Menu
15 Tracking enabling/disabling Key

# Front-Panel Menu/Key Reference

This section gives an overview of the front-panel keys/menus. The menus are designed to automatically guide you through all parameters required to configure a particular function or operation.

1 **Output1 selection key** Select the output1 voltage and current to be controlled and monitored on the display.

2 **Output2 selection key** Select the output2 voltage and current to be controlled and monitored on the display.

3 **Low voltage range selection key** Selects the low voltage range and allows its full rated output to the output terminals.

4 **High voltage range selection key** Selects the high voltage range and allows its full rated output to the output terminals.

5 **Overvoltage protection key** Enables or disables the overvoltage protection function, sets trip voltage level, and clears the overvoltage condition.

6 **Display limit key** Shows voltage and current limit values on the display and allows the knob adjustment for setting limit values.

7 **Resolution selection keys** Move the flashing digit to the right or left. Adjust the scrolling speed of the text being displayed in the View menu.

8 **Voltage/Current adjust selection key** Selects the knob control function for voltage or current adjustment.

9 **Knob** Increases or decreases the value of the flashing digit by turning clockwise or counter clockwise.

10 **Output On/Off key** Enables or disables the power supply output. This key toggles between on and off.

11 **I/O Configuration / Secure key**[3] Configures the power supply for remote interfaces / or secures or unsecures the power supply for calibration.

12 **View menu / Calibrate key**[2] Views the error codes and the text of the error message, calibration string, and system firmware revision / or enables calibration mode.

13 **State storage menu / Local key**[1] Stores up to five power supply's states and assigns a name to each of the storage locations / or returns the power supply to local mode from remote interface mode.

14 **Stored state Recall menu** Recalls a stored operating state from location "1" through "5" and resets the power supply to the power-on state (*RST command).

15 **Tracking enabling/disabling key** Enable / disable the track mode of the outputs.

[1] The key can be used as the "**Local**" key when the power supply is in the remote interface mode.

[2] You can enable the "calibration mode" by holding down this key when you turn on the power supply.

[3] You can use it as the "Secure" or "Unsecure" key when the power supply is in the calibration mode.

# EET 1122 Laboratory - Weekly Schedule

**Week**

1. Introduction to laboratory. Department rules, procedures, policies. Proper way to write a laboratory report.
2. Lecture on nature of Voltage, current, and resistance. Simple Ohm's Law examples.
3. Explain use of meters and the component kit; Experiment #1…Color Code
4. Experiment #2…Ohm's Law
5. Experiment #3…Series Circuits
6. Experiment #4…Parallel Circuits
7. Experiment #5…Series-parallel Circuits 1
8. MIDTERM EXAM
9. Experiment #6…Series-parallel Circuits 11
10. Experiment #7...Troubleshooting(resistance measurements)
11. Experiment #7…Troubleshooting(voltage measurements)
12. Experiment #8…Meter Sensitivity & Accuracy
13. Experiment #9 …Superposition
14. Experiment #10…Thevenin's Theorem
15. FINAL EXAM

**Note**: It is expected that the instructor will give a short lecture before each experiment.

TITLE: **COLOR CODE**

OBJECTIVES:
a) To gain practice in the use of the color code
b) To gain practice in use of K and in milliamp units
c) To learn the use of the multimeter
d) To determine whether a resistor is within its coded tolerance.

EQUIPMENT: Multimeter, Feedback Kit, Set of Resistors.

PRELIMINARY:

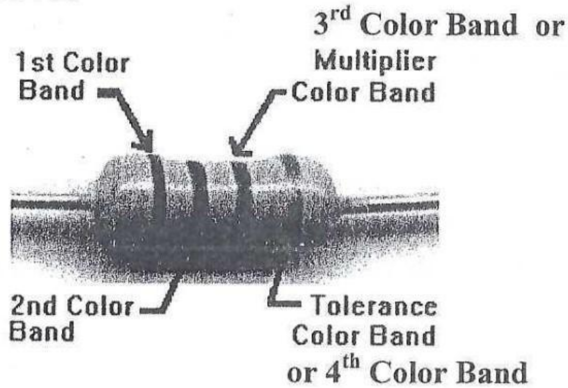
Before coming into the laboratory the student should make certain he is fully acquainted with the color code used to identify resistors.

A. The first three color bands around the resistor identify its resistance value.

1. Bands one and two identify the first two numbers in the resistance value according to the code below:

| | | | |
|---|---|---|---|
| Black | 0 | Green | 5 |
| Brown | 1 | Blue | 6 |
| Red | 2 | Violet | 7 |
| Orange | 3 | Gray | 8 |
| Yellow | 4 | White | 9 |

EXAMPLE:




Band one is brown- that stands for 1
Band two is black-that stands for 0.
Band three is red- that stands for 2
Therefore the value of the resistance is 10 and two zeros or 1000 Ω or 1KΩ.

B. The fourth band represents the percent tolerance of the resistor.

| | | |
|---|---|---|
| Silver | - | 10% |
| Gold | - | 5% |

For the above example the gold color band signifies that the range of the resistance value is: 1000Ω ± 5% of 1000Ω = 1000Ω ± 50Ω= [950Ω - 1050Ω]

C. Sometimes silver and gold are used in the third band. If so, silver signifies multiplication by 0.01.
Gold signifies multiplication by 0.1
Example: Red Green Gold = 25x0.1
= 2.5

PROCEDURE: The instructor will first give a short lecture-demonstration on the use of the multimeter.

RUN I:

A. Take a resistor from the sample tray provided.
B. Record its **COLOR CODE** in column 1 of the table 1.
C. Determine, using a color code chart, its **Coded Resistance**, in units of ohms (the symbol for which is $\Omega$). Write this coded resistance in column 2.
D. Determine, using the color code chart, the **Tolerance** (in percent) of the resistor, and record this tolerance in column 3.
E. Using the **Coded Resistance** and the **Tolerance**, find the **Maximum Coded Resistance**, and record this value in column 4.
F. Using the **Coded Resistance** and the **Tolerance**, find the **Minimum Coded Resistance**, and record this value in column 5.
G. Using the digital multimeter, set to the **Ohms** function, measure the resistance of the resistor. Note that you should always adjust the multimeter to obtain as many significant digits as possible. Record the **Measured Resistance** (using proper $\Omega$, $k\Omega$ or $M\Omega$ notation) in column 6.
The symbol **k** = kilo = 1,000; the symbol **M** = mega = 1,000,000.
H. Calculate the percent error given by

$$\frac{|\,\textit{coded resistance value} - \textit{measured resistance value}\,|}{\textit{coded resistance value}}\,100\%$$

Record the % error in column 7.
I. By comparing the measured resistance with the maximum and minimum coded resistances, decide if the resistor is within tolerance. Record the result (YES or NO) in column 8.
J. Repeat (A to I) for the other resistors.

**Refer to Table 1.** Study carefully the example given in the first row.
A resistor with a color-code of **"Red-Violet-Orange-Silver"** would have a **color-coded value of 27 k$\Omega$.**
**The color-coded tolerance would be ±10%**, and 10% of 27 k$\Omega$ is 2.7 k$\Omega$.

This means the resistor should have an actual measured value within the range of (27 k$\Omega$ – 2.7 k$\Omega$ = 24.3 k$\Omega$) and (27 k$\Omega$ + 2.7 k$\Omega$ = 29.7 k$\Omega$). So, any resistor with a color code of **Red-Violet-Orange-Silver** should have an actual value that lies within the range of 24.3 k$\Omega$ and 29.7 k$\Omega$. Mathematically, we would say that for the measured resistor to be within tolerance:

$$24.3k\Omega \le Rmeasured \le 29.7k\Omega$$

Since this sample resistor measures 25.1 k$\Omega$, it **IS** within its color-coded tolerance.

**Table 1:**

| Resistor's Color Code *(Record four color bands)* | Coded Resistance (Ω) | Tolerance (%) | Maximum Coded Resistance (Ω) | Minimum Coded Resistance (Ω) | Measured Resistance (Ω) | Percent error | Is the Resistor Within Tolerance? |
|---|---|---|---|---|---|---|---|
| **Red-Violet-Orange-Silver** | 27kΩ | 10% | 27k+2.7k = **29.7kΩ** | 27k-2.7k=**24.3kΩ** | 25.1 kΩ | 7 | YES** |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

****YES because: 24.3 kΩ ≤ 25.1kΩ≤29.7kΩ**

**Run II:**
**Body Resistance**
Guess the resistance of your body between your hands and record the value in table 2. Measure the resistance with the multimeter by firmly holding one lead in each hand (wetting your fingers will improve the reading), and record in the same table. If 10 mA are "lethal", what voltage (V=IR) would be required to produce the current through your body? Again record in table 2.

**Table 2:**

| Guessed body resistance | Measured body resistance | Lethal voltage |
|---|---|---|
| | | |

**REQUIRED RESULTS:**
As part of the regular laboratory report, write a brief set of procedures explaining how to measure resistance with a digital multimeter, including how to interpret the display so that the correct unit of measurement is associated with the numerical value.
Complete both tables 1 and 2. Explain the relation between column 7 and column 8 of table 1.

TITLE: **OHM'S LAW**

OBJECTIVES:
a) to become familiar with the use of DC voltmeters and ammeters.
b) to examine the relationships between the three basic quantities- current, voltage, and resistance.

EQUIPMENT:

| | |
|---|---|
| DC Voltmeter | Resistors- $R_2 = 680\ \Omega$ |
| DC Ammeter | $R_3 = 820\ \Omega$ |
| Box of Leads | $R_{10} = 1\ k\Omega$ |
| Feedback Kit | |

NOTE: Before proceeding with the experiment, make sure you understand the correct way to connect the meters. An ammeter has a very low resistance and must be inserted in series with the device whose current is to be measured. A voltmeter, on the other hand, has a very high resistance, and is always connected across the two points where potential difference is to be measured. When a meter has more than one scale (range), start connecting to the highest range first.

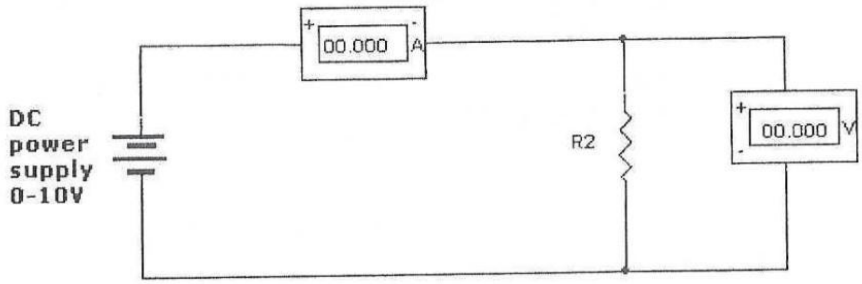
If any of the meters read negative (or downscale for analog meters), they are connected with the wrong polarity. Turn off the power and simply interchange the two leads on the meter.

POWER SUPPLY: At the start of the session, the instructor will explain the proper operation and connection of the power supply.

PROCEDURE: Make sure that the power supply is off.

1. Connect the circuit shown below. Have the instructor check your circuit, and after obtaining approval, apply power.
2. Adjust the voltage across the resistor to first 10 volts, then 9 volts, 8 volts, 7 volts, 6 volts, 5 volts, 4 volts, 3 volts, 2 volts, 1 volt, and 0 volt using the voltmeter, and record the voltage, and the ammeter reading at each step.
3. Repeat the above using $R_3$ instead of $R_2$.
4. Repeat the above using $R_{10}$ instead of $R_3$.

DIAGRAM:




REQUIRED RESULTS:

1. On a single sheet of engineering paper, plot a curve of voltage versus current for each of the three resistors.

2. From the curves plotted above, calculate the values of $R_2$, $R_3$, $R_{10}$.

Do this calculation twice for each resistor. Once from the point on the curve where the voltage = 5 volts, and once where I = 0.4 milliamps.

3. Assume a certain value of voltage. Which resistor draws the most current? Why?

4. What does the shape of the curves plotted above indicate?

TITE: **SERIES CIRCUITS**

OBJECTIVE: To verify current, voltage, and resistance relationships in a series circuit.

EQUIPMENT: DC Ammeter, AD; DC Voltmeter, VD; Box of Leads; Feedback Kit

$R_5$= 1 kΩ
$R_{10}$= 2.2 kΩ

PRELIMINARY:

Draw wiring diagrams ( similar to Fig.2) showing the circuits to be used in Run II C and Run II D and Run II E. THIS MUST BE PRESENTED TO THE INSTRUCTOR AT THE BEGINNING OF THE LABORATORY.

PROCEDURE:

RUN I: Individual Resistor Measurements

A. Connect the circuit of FIG. 1 using $R_5$ as the resistor.
B. After obtaining instructor's approval, turn power on.
C. Read and record the voltage and current.
D. Repeat the above using $R_{10}$ instead of $R_5$.

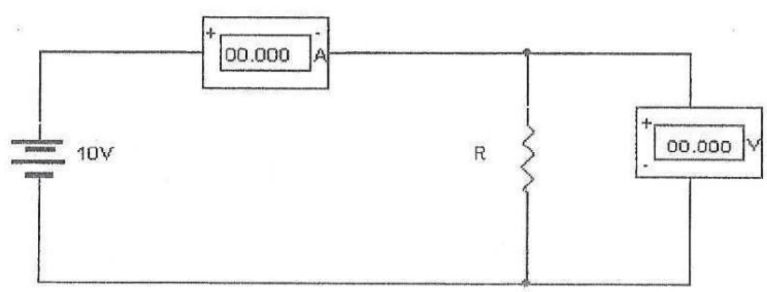



FIG. 1

RUN II: Current and voltage relationships.

A. Connect the circuit of FIG. 2

B. Read and record I, $V_{R5}$ and $V_{R10}$.

C. Change the position of the ammeter from the position shown to between $R_5$ and $R_{10}$and record I, $V_{R5}$ and $V_{R10}$.

D. Again, change the position of the ammeter so that now it is between $R_{10}$ and the negative side of the supply. Read and record I, $V_{R5}$ and $V_{R10}$.

E. Interchange the positions of $R_5$ and $R_{10}$ putting the ammeter in any of the above positions. Read and record I, $V_{R5}$ and $V_{R10}$.

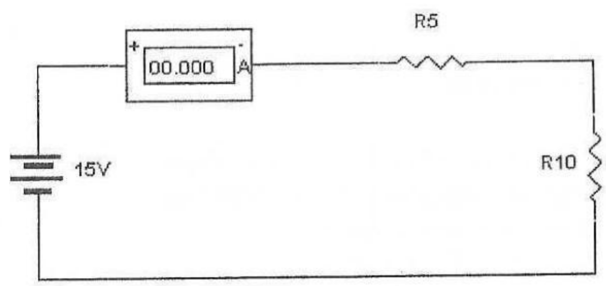



FIG. 2

REQUIRED RESULTS:

Q1 From the results of RUN I, calculate the values of $R_5$ and $R_{10}$.

Q2 From the results of RUN II B, calculate the values of $R_5$ and $R_{10}$.

Q3 Tabulate and compare the answers to Q1 and Q2.

Q4 For RUN II B, calculate the total resistance two ways ( i.e. $R = E/I_T$ and $R_T = R_5 + R_{10}$).

Q5 For RUN II B, compare the sum of the voltage drops across the resistors with the total voltage.

Q6 Show that the results of RUN II B follow the rules of voltage division for a series circuit.

Q7 What do the results of RUN II C, D, E, indicate?

NOTE: By **compare**, we mean calculate the percentage error or percentage difference.

$$\%\text{Error} = \frac{(\text{Standard value} - \text{measured value}) \times 100}{\text{Standard value}}$$

$$\%\text{Difference} = \frac{(\text{Value 1} - \text{Value 2}) \times 100}{\text{Value 1}}$$

EET1122.4

TITLE: **PARALLEL CIRCUITS**

OBJECTIVE: To study current, voltage, and resistance relationships in a parallel circuit.

EQUIPMENT: DC Volmeter, VD — $R_2 = 1k\Omega$
DC Ammeter, AD — $R_3 = 2.2k\Omega$
Feedback Kit — $R_{10} = 10k\Omega$

PROCEDURE:

RUN I: Individual Resistance Measurements

A. Wire the circuit of FIG.1 shown below.
B. Read and record I and V.
C. Repeat the above using $R_3$ instead of $R_2$.
D. Repeat the above using $R_{10}$ instead of $R_3$.

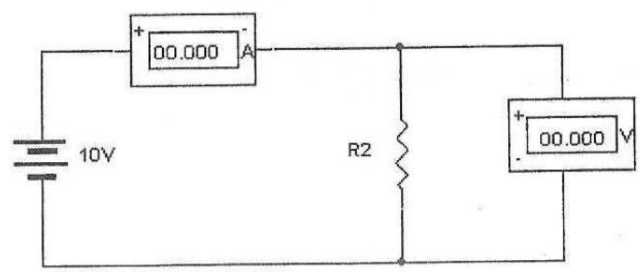



FIG. 1

RUN II: EFFECT OF ADDING BRANCHES

A. Again, wire the circuit of FIG.1 leaving out the voltmeter
B. Place $R_3$ in parallel to $R_2$ (see FIG.2) and read the ammeter current I.
C. Remove the ammeter from its present position to a position such that it reads the current in $R_2$ only. Record I.

NOTE: To accomplish part C above the ammeter must be in series with $R_2$ only. The ammeter- $R_2$ combination must be in parallel with $R_3$ as shown below.

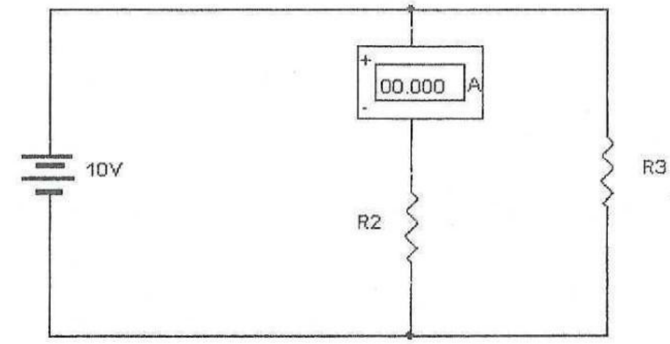



FIG. 2

D. Read and record $V_2$ and $V_T$.

E. Re- position the ammeter so that now it reads the current in $R_3$ only. Record I.

F. Add $R_{10}$ in parallel to $R_2$ and $R_3$.

G. Read and Record $I_T$ and $V_T$.

H. Read and record $I_2$ and $V_T$.

I. Read and record $I_3$ and $V_3$

J. Read and record $I_{10}$ and $V_{10}$.

REQUIRED RESULTS:

1. Did the voltage across $R_2$ change in any of the runs?
2. Did the current through $R_2$ change in any of the runs?
3. a) From RUN I, calculate $R_2$, $R_3$, $R_{10}$?
   b) For RUN II G, calculate $R_T$ two ways ( i.e. $R_T = E_T/I_T$)

   and $R_T = \dfrac{1}{1/R_2 + 1/R_3 + 1/R_{10}}$ and compare

IV. What effect did adding branch resistors have on the total current?

V. Why are power and lighting circuits such as those in the home usually connected in parallel.

EET1122.5

TITLE: **SERIES PARALLEL CIRCUITS I**

OBJECTIVE: To verify current, voltage, and resistance relationships in a series-parallel circuit.

PRELIMINARY: Before beginning the experiment, each student must submit a detailed solution for the circuits of FIG.1 and FIG.2. The student should solve for every value of voltage and current that the experiment asks him to measure.

EQUIPMENT:

| | |
|---|---|
| Feedback Kit | $R_5 = 470\ \Omega$ |
| DC Ammeter, AD | $R_6 = 820\ \Omega$ |
| $R_2 = 1000\ \Omega$ | $R_9 = 220\ \Omega$ |
| $R_3 = 680\ \Omega$ | $R_{10} = 330\ \Omega$ |

RUN I:

a. Wire the circuit of FIG. 1

b. Measure $V_{R2}$ , $V_{R3}$ , $V_{R9}$ , $V_{R10}$ , $V_X$ and record.

c. Measure $I_T$, $I_1$, $I_2$, and record.

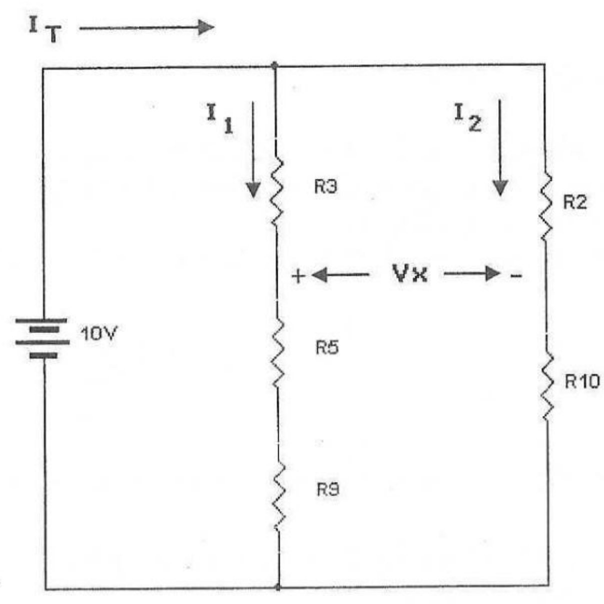



FIG.1

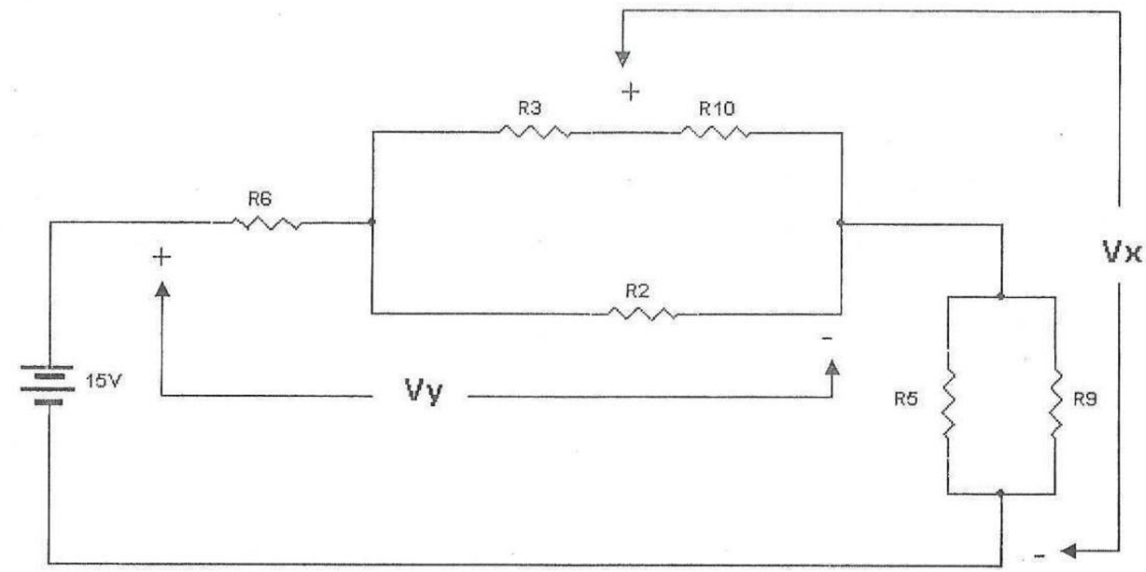



FIG. 2

RUN II:

A. Wire the circuit of FIG. 2.

B. Measure, $V_{R2}$ , $V_{R3}$ , $V_{R5,}$ $V_{R6,}$ $V_{R9}$ , $V_{R10}$ , $V_X$ $V_{Y.}$

C. Measure $I_{2,}$ $I_{3,}$ $I_5$, $I_{6,}$ $I_9$.

REQUIRED RESULTS:

1. Tabulate the measured values of voltage and current in RUN I and II with the calculated values and compare. This should be presented in tabular form as shown below:

| RUN I | Calculated | Measured | %Difference |
|---|---|---|---|
| $V_{R2}$ | | | |
| $V_{R3}$ | | | |
| ... | | | |
| ... | | | |
| $I_2$ | | | |
| ... | | | |
| ... | | | |

| RUN II | Calculated | Measured | %Difference |
|---|---|---|---|
| $V_{R6}$ | | | |
| … | | | |
| … | | | |
| $I_6$ | | | |
| … | | | |

2. For RUN I, compare the measured value of $I_T$ with the sum of $I_1$, and $I_2$, and explain.
3. For RUN I, compare the sum $V_{R3} + V_{R5} + V_{R9}$ with the sum $V_{R2} + V_{R10}$ and explain.
4. For RUN II B, compare the measured sum $V_{R6} + V_{R2} + V_{R5}$ with $V_{R6} + V_{R3} + V_{R10} + V_{R9}$ and explain.
5. For RUN II B, compare $V_X$ with the sum of $V_{R10} + V_{R9}$ and explain.
6. For RUN II B, compare $V_Y$ with the sum of $V_{R6} + V_{R2}$, and explain.
7. For RUN II C, compare the measured sums of $I_2$, + $I_3$, with $I_5 + I_9$ and explain.
8. Compare both sums found in Question 7 with $I_6$ and explain.

TITLE: **SERIES- PARALLEL CIRCUITS II**

OBJECTIVE: To verify current voltage and resistance relationships in a series parallel circuit.

PRELIMINARY: Before beginning the experiment, each student must submit a detailed solution for the circuits of FIG. 1 and FIG. 2. The student should solve for every value of voltage and current that the experiment asks him to measure.

EQUIPMENT:

| | |
|---|---|
| Feedback Kit | $R_5 = 470\ \Omega$ |
| AD | $R_6 = 820\ \Omega$ |
| VD | $R_9 = 220\ \Omega$ |
| $R_2 = 1000\ \Omega$ | $R_{10} = 330\ \Omega$ |
| $R_3 = 680\ \Omega$ | |

RUN I:

a) Wire the circuit of FIG. 1

b) Set the supply voltage (20 volts) using the meter and not the meter on the face of the supply.

c) Measure $V_{R2}$, $V_{R3}$, $V_{R5}$, $V_{R6}$, $V_{R9}$, $V_{R10}$, $V_X$ and record.

d) Measure $I_2$, $I_3$, $I_5$, $I_6$, $I_9$, $I_{10}$ and record.

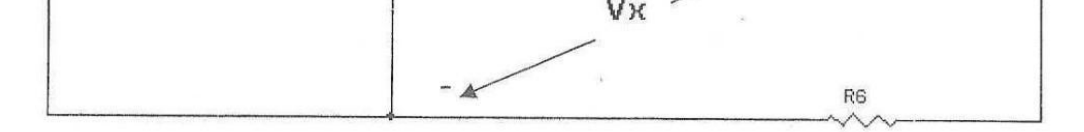



FIG. 1

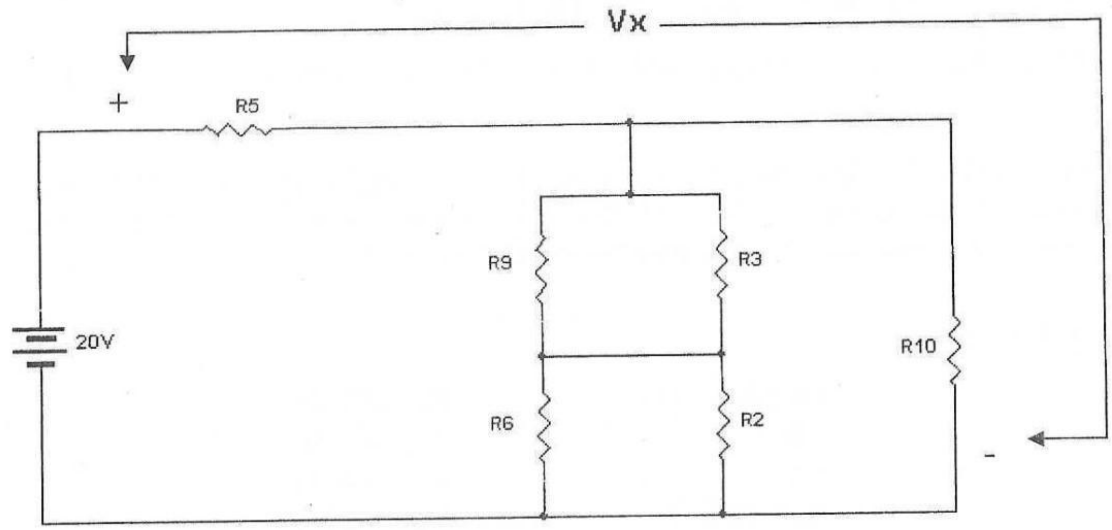



FIG. 2

RUN II : a) Wire the circuit of FIG. 2

b) Measure $V_{R2}$ , $V_{R3}$ , $V_{R5,}$ $V_{R6,}$ $V_{R9}$ , $V_{R10}$ , $V_X$ and record

c) Measure $I_2$, $I_3$, $I_5$, $I_6$, $I_9$, $I_{10}$ and record.

REQUIRED RESULTS:

1. Tabulate the measured values of voltage and current in RUN I and RUN II with the calculated values and compare. This should be presented in tabular form as shown below.

| RUN I | Calculated | Measured | Difference |
|---|---|---|---|
| $V_{R2}$ | | | |
| $V_{R3}$ | | | |
| ... | | | |
| ... | | | |
| ... | | | |
| $I_2$ | | | |
| $I_3$ | | | |
| ... | | | |
| ... | | | |
| ... | | | |
| ... | | | |

| RUN II | Calculated | Measured | Difference |
|---|---|---|---|
| $V_{R2}$ | | | |
| ... | | | |
| ... | | | |
| ... | | | |
| $I_{R2}$ | | | |
| ... | | | |
| ... | | | |
| ... | | | |

2. For RUN I , compare the measured value of $I_5$ with the sum of $I_2 + I_9 + I_{10}$ and explain

3. For RUN I , compare the sum of $I_9 + I_{10}$ with $I_3$ and explain.

4. For RUN I , compare $V_{R2}$ with the sum of $V_{R10} + V_{R3} + V_{R6}$ and explain.

5. For RUN I , compare $V_X$ with $V_{R3} + V_{R6}$ and with $V_{R2} - V_{R9}$ and explain.

6. For RUN II, compare $V_X$ with $V_{R5} + V_{R9} + V_{R2}$ and explain.

7. For RUN II, compare the sum of $I_9 + I_3$ with the sum $I_2 + I_6$ and explain.

8. For RUN II , compare $I_5$ with $I_{10} + I_9 + I_3$ and explain.

EET1122.7

TITLE: **TROUBLESHOOTING**

OBJECTIVE: To become familiar with the techniques of troubleshooting.

EQUIPMENT: Box of Leads
Multitester
Test Chassis ( is to be supplied by Instructor).

PRELIMINARY:

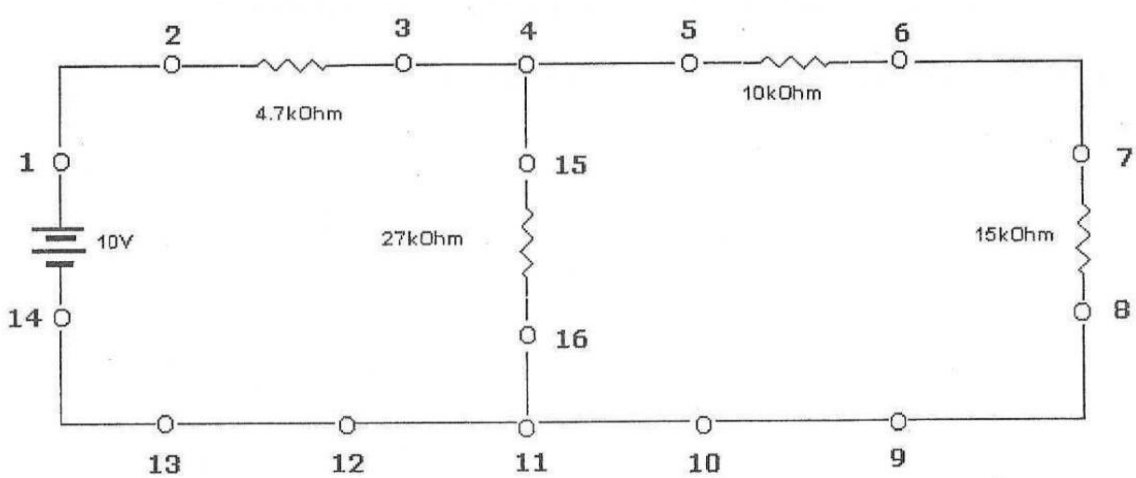
Before the start of the experiment, the student should submit a detailed solution in which he has calculated the value of the voltage across each resistor in FIG.1 below.

LECTURE :

The instructor will begin the laboratory session with a lecture demonstration on the use of the multitester ( volts and ohms scales) for troubleshooting purposes. The lecture should mention common faults and their symptoms.

PROCEDURE:

A. Each squad will be issued a test chassis upon which the following circuit is mounted.




Chassis diagram with labeled node connections

B. The instructor will indicate the amount of time allotted for each test chassis.
C. There are about twenty different chassis and each one has a different fault incorporated into it.
    1. There are some chassis with more than one fault. ( #'s 1-6)

D. Your data sheet should indicate ( in a neat logical manner)

1. the chassis number
2. the measurements taken

These should be indicated using double-script notation. Note that each test jack on the chassis is numbered on FIG.1. Refer to these numbers in recording your measurements. ( i.e. $V_{3\text{-}4}$ or $R_{7\text{-}8}$)

3. the scale on which these readings were taken.
4. A short explanation indicating which measurements enabled you to determine the fault(s).

**NOTE TO INSTRUCTOR:**

A. It is expected that this experiment will last two weeks. Week #1 should be without power and student should locate fault using resistance methods. Week #2 should be with 10 volts applied to the input and students should locate faults using voltage measurement.

B. Be reminded that chassis # 1-6 have two faults and students need additional explanation.

EET1122.8

TITLE: **METER SENSITIVITY AND ACCURACY**

OBJECTIVE: To study the effect of meter sensitivity on voltage measurements.

EQUIPMENT: DC Voltmeter (Parker) 500 ohms/volt
Multitester (20,000 ohms/volt)
Digital Voltmeter
Box of Leads
Precision resistors 1% ; 200 kΩ and 500 kΩ

Multitester:

1. Set the selector switch to the D-C position
2. Set the range switch to the proper voltage range
3. Connect the multimeter leads to the terminals marked "Common (-)" and "+"
4. The D-C scale has three sets of numbers, 0 to 10, 0 to 50, and 0 to 250. Select the scale to match the range and apply the proper decimal multiplier.

RUN I : INSTRUMENT ACCURACY

A. The instructor will set the supply voltage at each bench to 30 volts exactly with the digital voltmeter obtained from the stockroom.
DO NOT CHANGE THIS SETTING ON THE POWER SUPPLY.

B. Read and record the supply voltage using the DC voltmeter

C. Repeat using the multitester instead of the DC voltmeter.

RUN II: INSTRUMENT SENSITIVITY

A. Wire the circuit of FIG.1 on the next page
B. Using the DC voltmeter read and record $V_{AB}$, $V_{BC}$, and $V_{AC}$.
Also record the scale used to make these readings.
C. Repeat B using the multiteser instead of the DC voltmeter.
D. Repeat B using the digital voltmeter. (Call instructor when ready to perform this part. He will bring digital voltmeter to the bench.)

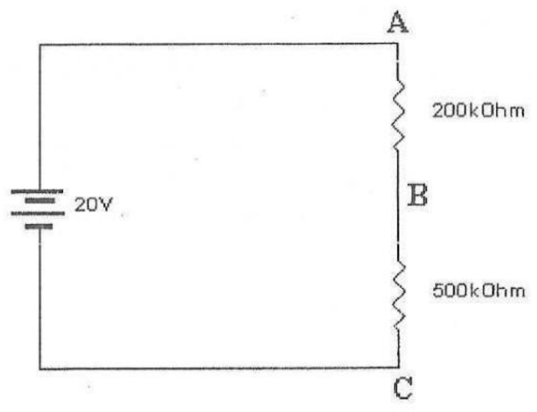



FIG. 1

REQUIRED RESULTS:

1. Based upon the results of RUN I, which meter is the most accurate? Least accurate?
2. Which instrument is the most sensitive? Least sensitive?
3. Which meter, by its presence in a circuit, causes the circuit to be changed the most?
4. At the beginning of the experiment sheet where the equipment is listed you will find that the sensitivity of each meter is noted. (This information can also be gotten from the face plate of the meters). From this information and a knowledge of the meter scale used, you can determine the input resistance of each of the meters. Using this knowledge, calculate $V_{AB}$, $V_{BC}$ that should be obtained in runs II.B , II.C, and II.D, and compare.

EET1122.9

TITLE: **SUPERPOSITION THEOREM**
OBJECTIVE: To verify the Superposition Theorem

PRELIMINARY PREPARATION: The student should calculate the current through $R_2$ in the given circuit below using the Superposition Theorem and the computer with the MultiSim Software before coming to class and present his/her work to the instructor.

EQUIPMENT: Feedback Kit
$R_5 = 470\ \Omega$
$R_2 = 1000\ \Omega$
$R_6 = 820\ \Omega$

RUN I

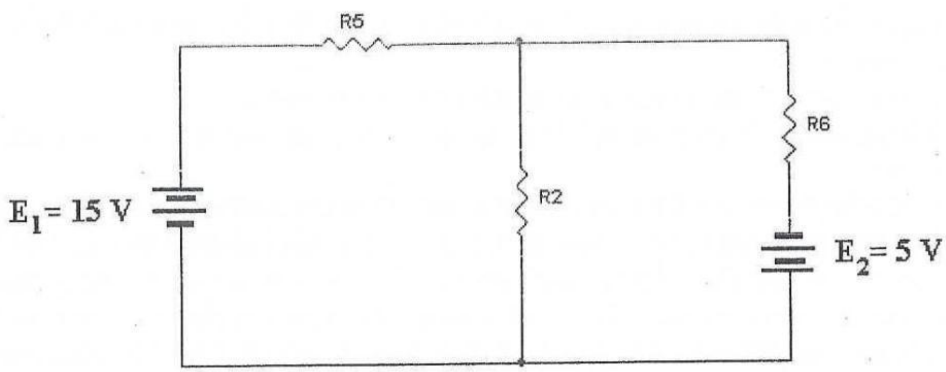



FIG. 1

a) Wire the circuit
b) Measure the current through $R_2$ and determine its direction
c) Disconnect $E_2$ and replace it with a short
d) Measure the current through $R_2$ and determine its direction.
e) Remove the short and put back $E_2$.
f) Remove $E_1$ and replace it with a short
g) Measure the current through $R_2$ and determine its direction.

REQUIRED RESULTS:

1. Add the results you obtained in steps d and g algebraically. Compare this value to the calculated value of the current through $R_2$.
2. Is the Superposition Theorem verified? Explain.
3. Solve for the current through $R_2$ if $E_2$ is replaced by a current source of 10mA.

EET1122.10

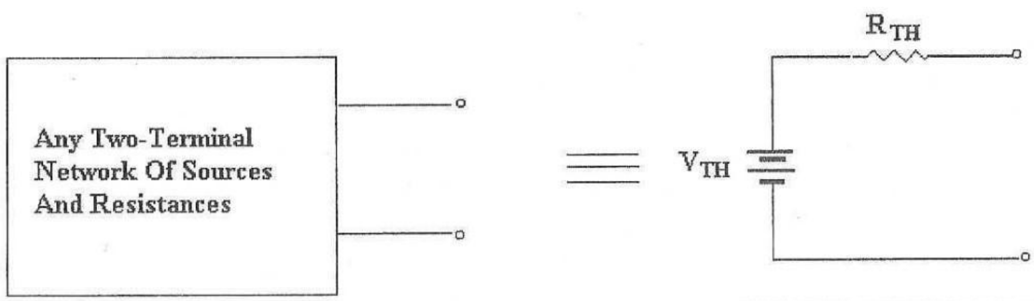
TITLE: **THEVENIN/NORTON'S THEOREM**

OBJECTIVE: To experimentally determine the Thevenin Equivalent circuit (TEC) for a linear network and verify the application of the Theorem.

PRELIMINARY PREPARATION: The student should research the two theorems in his/her textbook or appropriate reference and read this experiment through noting especially the required results at the end of this procedure.

BACKGROUND: According to Thevenin's Theorem any linear two terminal network having two output terminals can be replaced by a constant voltage source (1) and a series resistance (2).

(1) The Thevenin Voltage Source is the open circuit voltage ( with load disconnected) across the terminals for the load.
(2) The Thevenin Equivalent Resistance is the input resistance "seen" looking into the circuit from the load terminals with the load disconnected and all sources replaced by their internal impedances.




THEVENIN'S EQUIVALENT CIRCUIT

This simple equivalent two terminal circuit will act exactly as the replaced circuit for all possible two terminal loads.

We will obtain the Thevenin equivalent by making only two measurements with the load disconnected.

1) Measure $V_{OC}$ by placing a voltmeter across the opened load terminals.
2) Measure $I_{SC}$ by placing an ammeter across the opened load terminals.

$V_{TH} = V_{OC}$ and
$R_{TH} = V_{TH}/I_{SC}$

RUN I

A. Wire the circuit shown in FIG.1 below
B. Measure $I_L$ and $V_L$. ( the load is the 680 ohm resistor)
C. Remove the load resistor ( 680 ohms)
D. With the voltmeter in place of the load, read and record $V_{OC}$.
E. With the ammeter in place of the load, read and record $I_{SC}$.

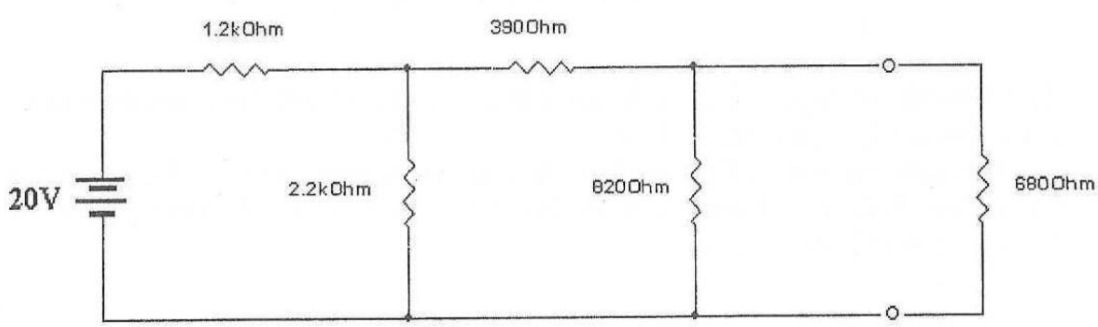



FIG. 1

RUN II
Thevenin equivalent resistance: Removing the 20V power supply and replacing it by a short (See FIG. 2), measure with the DMM the resistance($R_{TH}$) seen by the load.

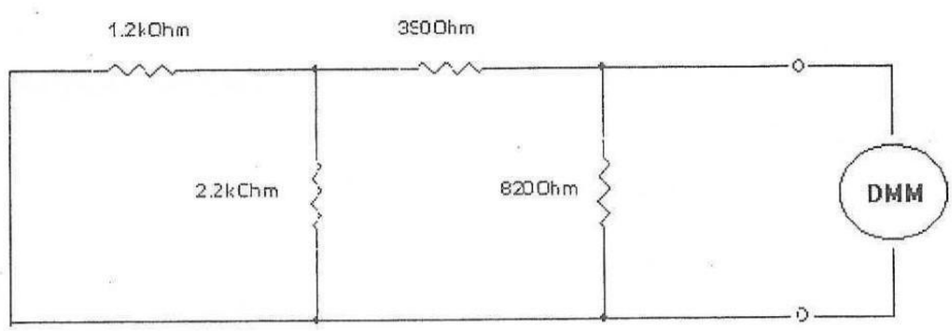



FIG. 2

RUN III

A. Wire the circuit shown in Fig.3 below. $V_{TH}$ and $R_{TH}$ are calculated from the equations on page 28 and the measurements from Run 1D and 1E. Note: It may be necessary to "build" $R_{TH}$ from a number of resistors to get a close enough (10%) value.

B. Measure and record $V_L$ and $I_L$.

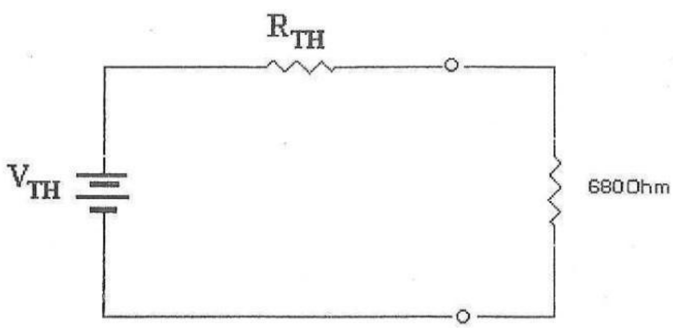



FIG. 3

REQUIRED RESULTS:

1. Compare, tabulate, and discuss the values of $V_L$ and $I_L$ obtained in Run I, with those obtained in Run III.
2. Compare the calculated value of the Thevenin equivalent resistance (RUN I) with the measured value (RUN II).
3. What approximation is made when we say that the measurement in Run 1D is $V_{OC}$?
4. What approximation is made when we say that the measurement in Run 1E is $I_{SC}$?