X090994

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

Department of Electrical Engineering

Experiment No.__________Network Analysis

INTRODUCTION

The purpose of this experiment is to mathematically analyze an electrical network, then to build the network and compare measured data with calculated data. Also, a simple error analysis will be made.

All measuring instruments have some inherent inaccuracies associated with them. THe accuracy of measurement of a digital meter is generally expressed as a percentage of the reading plus a number of least significant digits (or counts). The percentage and digits can differ on different ranges of the meter. Below are the DC current accuracy specifications for the Hewlett-Packard Models 3466A and 3468A/B digital multimeters (DMM).

LABVOLT Model 762 DMM			
Range	Maximum Display	Shunt Resistance	Accuracy
20 uA	19.99	10000 ohms	±(1.5% of reading + 1 count)
200 uA	199.9	1000 ohms	±(1.5% of reading + 1 count)
2 mA	1.999	100 ohms	±(1.5% of reading + 1 count)
20 mA	19.99	10 ohms	±(1.5% of reading + 1 count)
200 mA	199.9	1 ohm	±(1.5% of reading + 1 count)
2000 mA	1999	0.1 ohms	±(1.5% of reading + 1 count)

Hewlett-Packard Model 3468A/B DMM		
Range	Shunt Resistance	Accuracy
3A, < 1 A	0.1 ohms	±(.17% of reading + 6 counts)
3A, > 1 A	0.1 ohms	±(1.0% of reading + 30 counts)
Maximum Display ±3.00001		

It can be seen from the information above that measurements taken from the upper end of a range will tend to be the more accurate than measurements taken from the lower end of a range. Of course, to maintain the accuracy of an instrument, it should be calibrated periodically.

Suppose the Hewlett-Packard Model 3468A/B DMM is used to check Kirchhoff's current law at a four-element node where all four current readings are less than 1 ampere each. Then the MAXIMUM possible error in the current sum due to the meter inaccuracy would be:

$$\text{Error} = \pm[0.0017(|I1| + |I2| + .. + |In|) + 6n \text{ digits}]$$

where n is equal to 4.

Element	Reading ± error (amperes)		
1	+0.02000 + 0.00003 + 0.00006	or	+0.02000 - 0.00003 - 0.00006
2	-0.01300 + 0.00002 + 0.00006	or	-0.01300 - 0.00002 - 0.00006
3	+0.01700 + 0.00003 + 0.00006	or	+0.01700 - 0.00003 - 0.00006
4	-0.02400 + 0.00004 + 0.00006	or	-0.02400 - 0.00004 - 0.00006
Sum =	0.00000 + 0.00012 + 0.00024	or	0.00000 - 0.00012 - 0.00024
Error =	+0.00036	or	-0.00036

PRELIMINARY

P-1. Verify Kirchhoff's current law for all the nodes in the network in Figure 1 using the calculated data from Figure 3.

P-2. Verify Kirchhoff's voltage law for the network in Figure 1 using the calculated data from Figure 3. Sum voltages around at least 5 closed paths. As each new path is traversed, it should contain at least one new element that has not been included in any of the previous paths.

P-3. For the current equations in Preliminary P-1 above, calculate the maximum possible error that could result from using the LABVOLT model 762 DMM.

(INSTRUCTOR'S SIGNATURE____________________________DATE__________)

PROCEDURE

L-1. Connect the circuit of Figure 1 according to the wiring diagram in Figure 2. MAKE SURE THAT THE CURRENT AND VOLTAGE SOURCES ARE NOT GROUNDED! The “Node1 blocks” are included in the circuit to measure current without having to “break” the circuit to insert an ammeter. They are also designed such that a negative current reading means that the current is flowing INTO the “nodel block.” Please notice the REOrIENTATION of the nodes and the use of only two voltage sources. Also notice in Figure 3 that the element currents and voltages are identified by number and nodel subscripts.

L-2. Measure and record all the element voltages (across the appropriate nodes) NOTING POLARITY.

L-3. Measure and record all the element currents (at the appropriate “nodel block”) NOTING POLARITY.

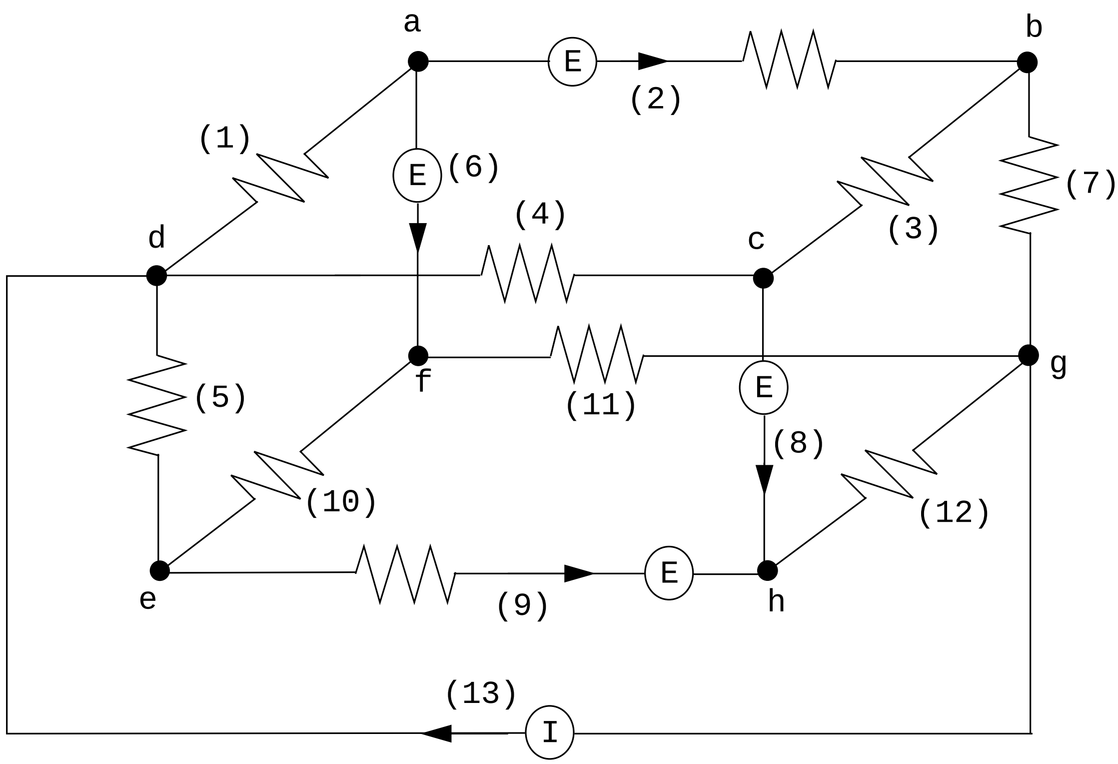
REPORT (should include at least the following)

R-1. Tabulate the calculated and measured values of currents and voltages showing percent error in each case. Use the calculated value as base; note sign.

R-2. Calculate the power for each element, noting sign. Sum the power.

R-3. Sum the currents for each node using MEASURED values of current. Check to see if the measurements are within the accuracy of the meter. (The error data in Preliminary P-3 can be used for comparison.) Tabulate the data.

R-4. Discuss your results -- especially sources of error!



E2 = 24 Volts	R1 = 2000 Ohms	R7 = 5000 Ohms
E6 = 24 Volts	R2 = 4000 Ohms	R9 = 8000 Ohms
E8 = 40 Volts	R3 = 2000 Ohms	R10 = 1200 Ohms
E9 = 40 Volts	R4 = 1200 Ohms	R11 = 4000 Ohms
I13 = 0.004 Amperes	R5 = 3000 Ohms	R12 = 3000 Ohms

Figure 1. Network

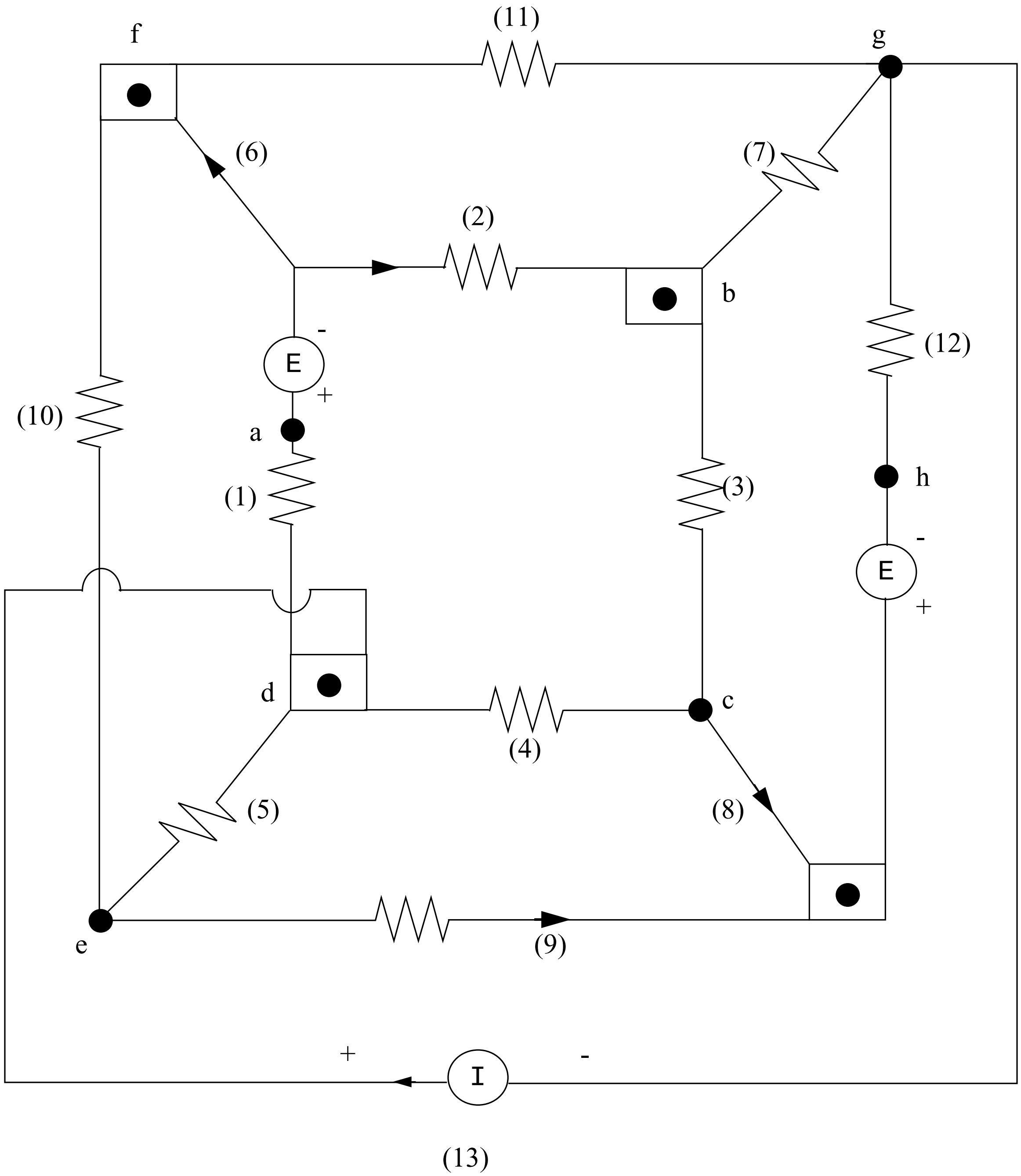


Figure 2. Wiring Diagram

Current (milliamperes)	Voltage (volts)
I1da = -2.798	V1da = -5.596
I2ab = -1.230	V2ab = 19.080
I3cb = 5.102	V3cb = 10.202
I4dc = 2.734	V4dc = 3.281
I5de = 4.064	V5de = 12.191
I6af = -1.568	V6af = E6a = 24.000
I7bg = 3.871	V7bg = 19.356
I8ch = -2.366	V8ch = E8 = 40.000
I9eh = -1.114	V9eh = 31.091
I10ef = 5.178	V10ef = 6.221
I11fg = 3.609	V11fg = 14.437
I12hg = -3.480	V12hg = -10.441
I13gd = I13 = 4.000	V13gd = -32.840

Figure 3. Calculated Currents and Voltages