NEPAL COLLEGE OF INFORMATION TECHNOLOGY

Balkumari Lalitpur

(Affiliated to Pokhara University)

A Lab Report
On

Subject: - Instrumentation

Initial Checked

Lab Report #. 1

Title: - To calculate absolute error, relative error, percentage error of currents in given error.

Submitted By:

Name: - Niraj Bhatta

Roll No.: - 231326

Faculty: - BCE

Year/Semester: - 2nd sem

Submitted To:

Instructor I: - Umang Sir

Department of Electronics and communation Engineering

Submission Date: - 2081-02-01

Experiment no·1

TO CALCULATE ABSOLUTE ERROR, RELATIVE ERROR AND PERCENTAGE ERROR OF CURRENTS IN A GIVEN ERROR

APPARATUS REQUIRED:

a) power supply
b) Ammeter
c) Multimeter
d) calculator
e) Data recording Tools

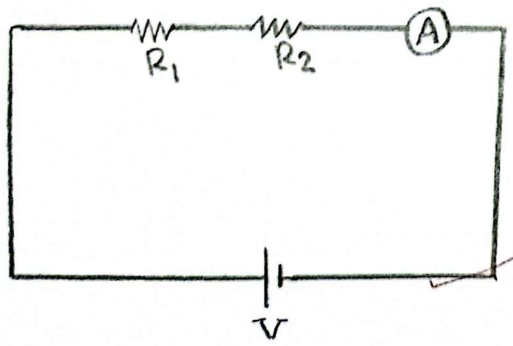
OBJECTIVE

- To be able to know about basics of different errors and calculate them in real life datas.

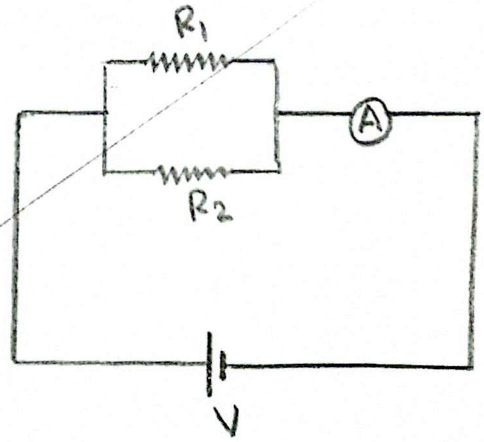
COMPONENTS REQUIRED:

a) Resistor (466Ω, 986Ω)
b) wires
c) Bread Board

CIRCUIT DIAGRAM:



Fig(a)



Fig(b).

THEORY:

Absolute error is defined as the difference between the actual value and the measured value of a quantity. The importance of absolute error depends on the quantity that we are measuring. If the quantity is large such as road distance, a small error in centimeter is negligible.

The absolute error is calculated by the subtraction of the actual value and the measured value of a quantity.

$$\text{Absolute error} = \text{Actual value} - \text{measured value}$$

The ratio of absolute error of the measurement and the actual value is called relative error. By calculating the relative error, we can have an idea of how good the measurement is compared to the actual size. From the relative error, we can determine the magnitude of absolute error. The relative error is dimensionless and it has no unit. ~~It is wri~~

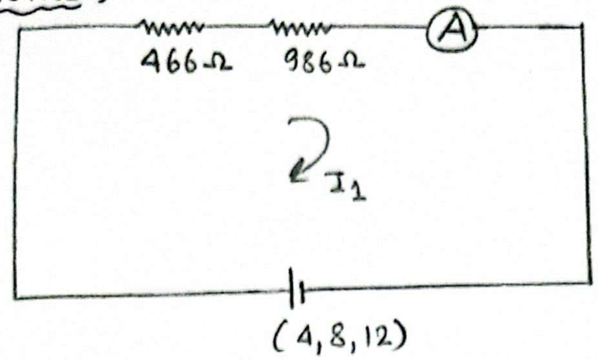
$$\text{Relative error} = \frac{\text{Absolute error}}{\text{Actual error}}$$

Percent error is the difference between estimated value and the actual value in comparision to the actual value and is expressed as a percentage. In other words, the percent error is the relative error multiplied by 100.

$$\text{Percentage error} = \frac{|\text{Estimated value} - \text{Actual value}|}{\text{Actual value}} \times 100\%$$

CALCULATION:

1) In series;



Applying KVL,

① When supply is 4V,

$$4 - 466 I_1 - 986 I_1 = 0$$

$$\text{or, } 4 - 1452 I_1 = 0$$

$$\text{or, } I_1 = 2.75 \text{ mA}$$

⑪ When supply is 8V;

$$8 - 1452 I_1 = 0$$

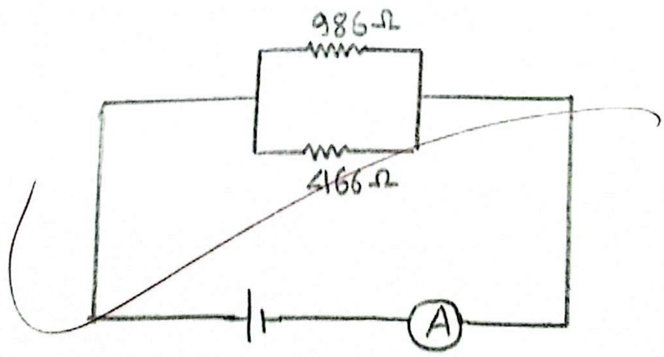
$$\text{or, } I_1 = 5.5096 \text{ mA}$$

⑪ When supply is 12V;

$$12 - 1452 I_1 = 0$$

$$\text{or, } I_1 = 8.26 \text{ mA}$$

2) In parallel;



The equivalent resistance is,

$$R_{eq} = \frac{986 \times 466}{986 \times 466}$$

$$= 316.44\,\Omega$$

So,

Applying KVL,

For 4V

$$4 - 316.44 I_1 = 0$$

$$\text{or, } I_1 = 12.6 \text{ mA}$$

For 8V

$$8 - 316.44 I_1 = 0$$

$$\text{or, } I_1 = 25.2 \text{ mA}$$

For 12V

$$12 - 316.44 I_1 = 0$$

$$\text{or, } I_1 = 37.92 \text{ mA.}$$

OBSERVATION:

S.N	Supply volt	True value	Measured value
1.	4V	2.75mA	3mA
2.	8V	5.5096mA	5mA
3.	12V	8.26 mA	8 mA

This table is for series combination.

The table for parallel combination is;

S.N	Supply Volt	True value	Measured value
1.	4V	12.6 mA	13 mA
2.	8V	25.2 mA	26 mA
3.	12V	37.92mA	40 mA

For series :

For 4V

Absolute error = |T.V − M.V|

= |2.75 − 3|

= 0.25 mA

Relative error = $\frac{|T.V - M.V|}{T.V}$

= $\frac{0.25}{2.75}$ = 0.0909

percentage error = $\frac{|T.V - M.V|}{T.V} \times 100\%$

= 0.0909 × 100 %

= 9.09 %

Similarly,

For 8V

Absolute error = 0.5096 mA

Relative error = 0.092

percentage error = 9.2 %

For 12V

Absolute error = 0.26 mA

Relative error = 0.031

percentage error = 3.1 %

For parallel,

For 4V

Absolute error = 0·4 mA
Relative error = 0·031
percentage error = 3·1 %.

For 8V

Absolute error = 0·8 mA
Relative error = 0·0317
percentage error = 3·17 %.

For 12V

Absolute error = 2·08 mA
Relative error = 0·054
percentage error = 5·4 %.

DISCUSSION:

Firstly, a bread board was taken and the required circuit (i.e series or parallel) was setup using jumper wires, ammeter and power supply (4V, 8V, 12V).

After setting up the circuit, the current through the resistors were obtained theoritically using KVL rule and named them as true value for different supplies. ~~Here~~ Then the Measured value was obtained from the ammeter and are noted. With the help of true value and measured value, absolute error, relative error and percentage error were calculated for different supply voltage i.e 4V, 8V and 12V.

RESULTS:

For the series combination,

For 4V, Absolute error = 0.25mA
Relative error = 0.0909
Percentage error = 9.09%

For 8V, AE = 0.5096 mA, RE = 0.092, P.E = 9.2%.

For 12V, AE = 0.26 mA, RE = 0.031, P.E = 3.1%.

For the parallel combination,

Volts	A.E	R.E	P.E
4V	0.4	0.031	3.1%
8V	0.8	0.0317	3.17%
12V	2.08	0.054	5.4%

CONCLUSION:

Absolute error, Relative error and Percentage error was calculated from this experiment of errors.

NEPAL COLLEGE OF INFORMATION TECHNOLOGY

Balkumari Lalitpur

(Affiliated to Pokhara University)

A Lab Report
On

Subject: - INSTRUMENTATION

Initial Checked

Lab Report # 2

Title: - TO MEASURE THE VALUE OF UNKNOWN RESISTANCE IN A BALANCED WHEAT STONE BRIDGE

Submitted By:

Name: - NIRAJ BHATTA

Roll No.: - 231326

Faculty: - BCE

Year/Semester: - SECOND

Submitted To:

Instructor I: - UMANG SIR

Department of Electronics and communication.

Submission Date: - 2081-02-08

Experiment no. 2

TO MEASURE THE VALUE OF UNKNOWN RESISTANCE IN A BALANCED WHEAT STONE BRIDGE CIRCIUT

OBJECTIVE :

- To measure an unknown electrical resistance by comparing it to known resistance in a balanced bridge configuration.

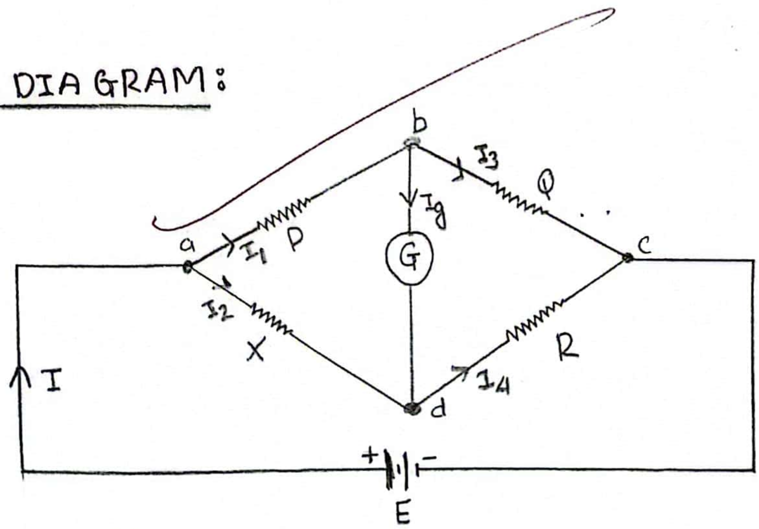
APPARATUS REQUIRED :

1. power supply (5V)
2. Galvanometer
3. Multimeter
4. Bread Board

COMPONENTS REQUIRED :

1. Resistors (1kΩ, 0.47 kΩ, 0.22kΩ).
2. Jumper wires.
3. potentiometer

CIRCUIT DIAGRAM :



[Fig: wheat-stone bridge]

THEORY:

Wheat stone bridge is an electric device which is used for accurate measurement of conductor. It can also be defined as an arrangement of four ~~resistances~~ resistors connected in the form of bridge in which three resistors are known and one unknown resistor is measured in terms of three resistors.

When the cell is connected in the circuit and values of resistors are adjusted in such a way that galvanometer shows null deflection and bridge is said to be balanced. At balanced condition, the current flowing through galvanometer is zero (i.e potential at B is equal to potential at D) and product of resistance in opposite arm is equal.

i.e.

$$\boxed{PR = XQ}$$

This is the working principle of wheatstone bridge.

A wheatstone bridge circuit consists of four arms, of which two arms consist of known resistances while the other two arms consist of an unknown resistance and a variable resistance. This circuit consists of a Galvanometer and an electromotive force source. The emf source is attached between points a and b while the galvanometer is connected between points c and d. The current that flows through the galvanometer depends on its potential difference.

proof:

Suppose initially the bridge is not balanced. Then,

Let, I_1 = current flowing through resistor P

I_2 = current flowing through resistor X

I_3 = current flowing through resistor Q

I_4 = current flowing through resistor R

R_g = galvanometer resistance.

Now,

Applying KCL at node/junction 'b',

$$I_1 = I_g + I_3 \text{ -------- (i)}$$

Applying KCL at junction (d)

$$I_2 + I_g = I_4 \text{ ------ (ii)}$$

Now, Applying KVL at loop abda;

$$-I_1P - I_gR_g + I_2X = 0$$

$$\therefore I_1P + I_gR_g - I_2X = 0 \text{ -------- (iii)}$$

Applying KVL at loop bcdb;

$$-I_3Q + I_4R + I_2X = 0$$

$$\text{or, } I_4R + I_2X = I_3Q \text{ ------- (iv)}$$

Now, value of resistors are adjusted in such a way that current flowing through galvanometer is zero. Using $I_g = 0$ in above four equations;

$$I_1 = I_3 \text{ —— (v)}$$

$$I_2 = I_4 \text{ —— (vi)}$$

$$I_2X = I_1P \text{ —— (vii)}$$

$$I_4R = I_3Q \text{ —— (viii)}$$

Finally, Dividing eqn (vii) by (viii),

$$\frac{I_4R}{I_2X} = \frac{I_3Q}{I_1P} \Rightarrow \boxed{\frac{P}{Q} = \frac{X}{R}}$$

$[I_1 = I_3,\ I_4 = I_2]$

~~Observatio~~

OBSERVATION:

Measured value			True Value		
P (kΩ)	Q (kΩ)	R (kΩ)	P (kΩ)	Q (kΩ)	R (kΩ)
0.986kΩ	0.465kΩ	0.220kΩ	1kΩ	0.470 kΩ	0.220 kΩ

Now,

calculating 'x',

For measured value:

$$X_m = \cancel{\frac{PR}{Q}} = 0.46640\ k\Omega$$

$$= \cancel{\frac{0.986 \times 0.22}{0.465}}$$

$$= 0.46640\ k\Omega$$

For True Value:

$$X_T = \frac{PR}{Q}$$

$$= \frac{1 \times 0.220}{0.470}$$

$$= 0.4680\ k\Omega$$

ERROR CALCULATIONS:

Absolute error $= |T.V - M.V|$

$= 0.0016$

Relative error $= \frac{\text{Absolute error}}{\text{True value}} = \frac{0.0016}{0.4680} = 0.0034$

Percentage error $=$ relative error $\times 100\%$

$= 0.0034 \times 100\%$

$= 0.34\%$

DISCUSSION:

Firstly, a bread board was taken and the required circuit (i.e. series or parallel) of the resistors, Galvanometer, etc was set up using jumper wires.

After setting up the wheat-stone bridge arrangements, The resistors were measered using multimeter respectively. The measured value were noted. The true value for the resistors were 1KΩ, 0.47KΩ and 0.22KΩ. Then, the unknown resistance 'x' was measured using a device called potentiometer. By making the galvanometer deflection null, the shaft of potentiometer was rotated and was measured. lastly, the value of unknown resistance for the true datas was calculated using balanced condition formula of wheat-stone bridge.

Finally, By compairing all the datas, absolute error, relative error and percentage error was found for unknown resistance measurement using wheat-stone bridge.

RESULTS:

$P = 0.986 K\Omega$
$Q = 0.465 K\Omega$
$R = 0.220 K\Omega$
$X = 0.4664 K\Omega$

$P' = 1 K\Omega$
$Q' = 0.470 K\Omega$
$R' = 0.220 K\Omega$
$X' = 0.4680 K\Omega$

absolute error = 0.0016
relative error = 0.0034
percentage error = 0.34%

CONCLUSION:

The unknown resistance was calculated using wheat stone bridge and the errors are also calulated mentioning it's true value and measured value of resistances.

NEPAL COLLEGE OF INFORMATION TECHNOLOGY

Balkumari Lalitpur

(Affiliated to Pokhara University)

A Lab Report
On

Subject: - INSTRUMENTATION

Initial Checked

Lab Report #. 3

Title: - Wheatstone bridge (Unbalanced condition)

Submitted By:

Name: - Niraj Bhatta

Roll No.: - 231326

Faculty: - BE. Computer

Year/Semester: - Second sem

Submitted To:

Instructor I: - ~~Umang~~ sir (UMP sir)

Department of Electronics and communication.

Submission Date: - 2081-02-22

Experiment no. 3

TO MEASURE THE VALUE OF UNKNOWN IN A UNBALANCED WHEATSTONE BRIDGE CIRCUIT

OBJECTIVE:

- To measure the current through galvanometer of unbalanced wheatstone bridge circuit.

APPARATUS REQUIRED:

1. power supply (5V)
2. Multimeter
3. Bread board
4. Galvanometer

COMPONENTS REQUIRED:

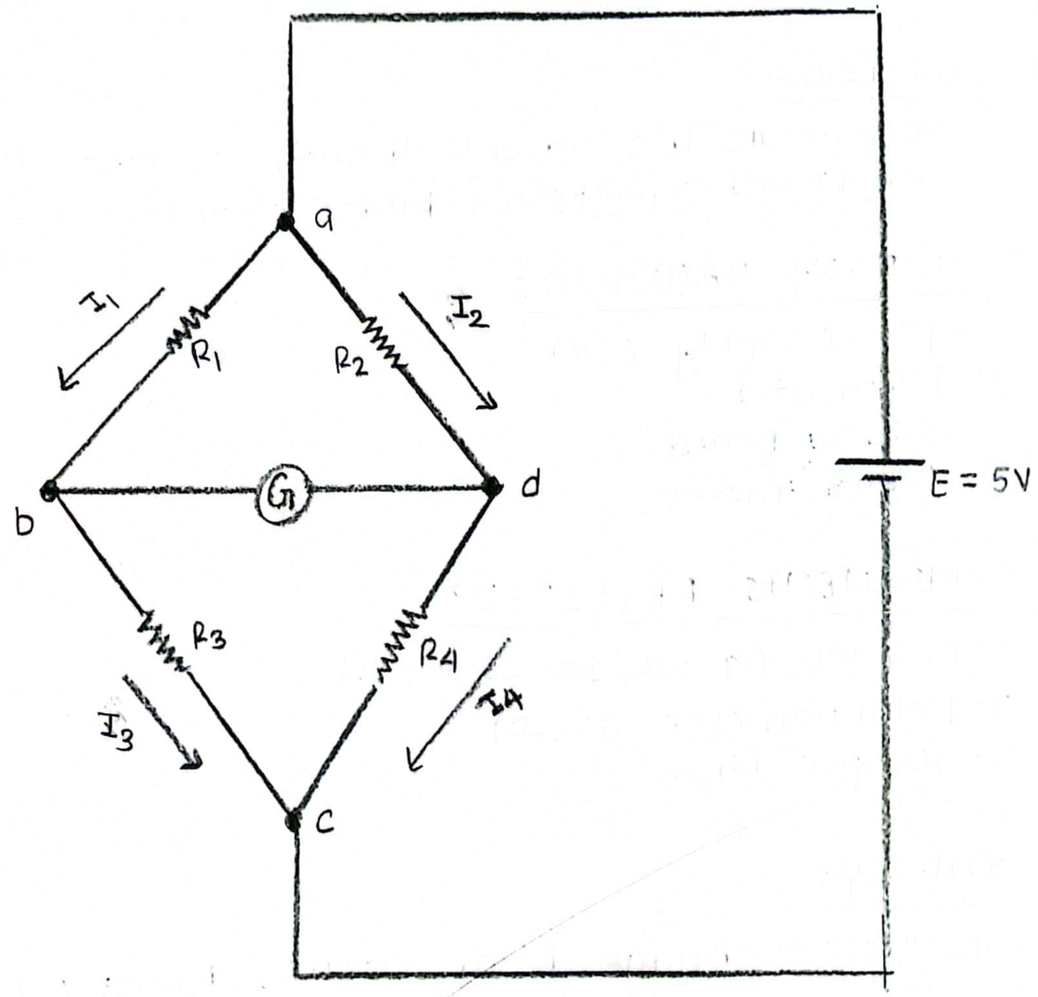
1. Resistors (470Ω, 1000Ω, 220Ω)
2. potentiometer (450Ω)
3. jumper wire.

THEORY:

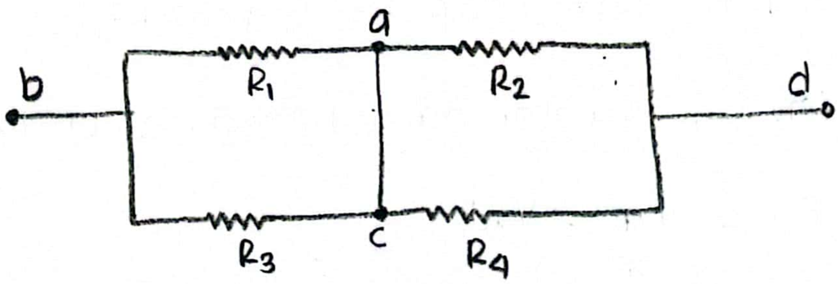
wheat stone bridge is an electric device which is used for accurate measurement of conductor. It can also be defined as an arrangement of four resistors connected in the form of bridge in which three resistors are known and one unknown resistor is measured in terms of three resistors.

The equation for unbalanced wheatstone bridge circuit is;

$$E_{th} = V_{ab} - V_{ad}$$
$$= \left(\frac{E}{R_1+R_3}\right) R_1 - \left(\frac{E}{R_2+R_4}\right) R_2$$



[Fig: Unbalanced wheatstone bridge]



[Fig: Equivalent circuit]

$$\therefore E_{th} = E\left(\frac{R_1}{R_1+R_3} - \frac{R_2}{R_3+R_4}\right) \quad \text{------ (I)}$$

Now,

The R_{th} is,

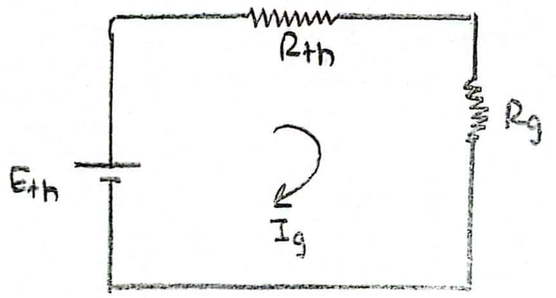
$$R_{th} = (R_1 // R_3) + (R_2 // R_4)$$

$$= \frac{R_1 R_3}{R_1+R_3} + \frac{R_2 R_4}{R_2+R_4}$$

$$\therefore R_{th} = \frac{R_1 R_3}{R_1+R_3} + \frac{R_2 R_4}{R_2+R_4} \quad \text{------- (II)}$$

Again,

The thevenin's equivalent circuit is,



where, R_g = resistance of galvanometer.

$$\therefore I_g = \frac{E_{th}}{R_{th}+R_g} \quad \text{-------- (III)}$$

OBSERVATION:

Measured value				True value			
R_1	R_2	R_3	potentiometer R_4	R_1'	R_2'	R_3'	R_4'
470 Ω	1000 Ω	220 Ω	450 Ω	463 Ω	977 Ω	217 Ω	450 Ω

Now,

From the Galvanometer,

$$(I_g) = 2 \text{ divisions}$$
$$= 2 \times 20 \mu A$$
$$= 40 \mu A$$

Now,

For True value,

$$E_{th} = 5 \times \left(\frac{463}{463+217} - \frac{977}{463+977} \right)$$
$$= 0.012050 \text{ Volts.}$$

Now,

$$R_{th} = \frac{463 \times 220}{463 + 220} + \frac{977 \times 450}{977 + 450}$$
$$= 457.230 \Omega$$

Lastly,

I_g for true value,

$$I_g = \frac{E_{th}}{R_{th} + R_g}$$
$$= \frac{0.012050}{457.230 + 169}$$
$$= 19.24 \times 10^{-6} \mu A$$

ERRORS

$$\text{Absolute error} = |T.V - M.V|$$
$$= |-19.24 \times 10^{-6} + 40 \times 10^{-6}|$$
$$= 20.76 \mu A$$

$$\text{Relative error} = \frac{|T.V - M.V|}{T.V}$$
$$= \frac{20.76 \mu A}{40 \mu A}$$
$$= 0.519$$

percentage error = Relative error × 100%

= 0.519 × 100%

= 51.9 %

DISCUSSION:

Firstly, a bread board was taken and the required circuit (i.e series or parallel) of the resistors, Galvanometer, etc was set up using jumper wires.

~~Beforing~~ Before setting up the arrangements; R_1, R_2 and R_3 were measured using multimeter and were noted. The value of R_4 was made 450 Ω using potentiometer and multimeter. Then the resistance of galvanometer (R_g) was also noted with the help of multimeter. Finally, the arrangements were set up. After setting up the arrangements the value of current (I_g) was observed in galvanometer and it was found to be 40 μA. Then the value of current (I_g) was again calculated for measured values of data using unbalanced wheat stone bridge condition.

Finally, By compairing all the datas, absolute error, relative error and percentage error was found for the currents using unbalanced wheat-stone bridge.

RESULTS:

R_1 = 470 Ω

R_2 = 1000 Ω

R_3 = 220 Ω

R_4 = 450 Ω

$(I_g)_m$ = 40 μA

R_1' = 463 Ω

R_2' = 977 Ω

R_3' = 217 Ω

R_4' = 450 Ω

$(I_g)_M$ = 19.24 μA.

Absolute error = 20.76 μA
Relative error = 0.519
percentage error = 51.9%

CONCLUSION:

The current was calculated using unbalanced wheat stone bridge and the errors are also calculated mentioning it's true value of resistances.

NEPAL COLLEGE OF INFORMATION TECHNOLOGY

Balkumari Lalitpur

(Affiliated to Pokhara University)

A Lab Report
On

Subject: - Instrumentation

Initial Checked

Lab Report #. 04

Title: - Resistance temperature detector.

Submitted By:

Name: - Niraj Bhatta

Roll No.: - 231326

Faculty: - BE. computer

Year/Semester: - 2nd semester

Submitted To:

Instructor I: - Umang sir

Department of Electrical and electronics communication.

Submission Date: - 2081-03-04

Title: Resistance Temperature detector

Objective:

- To study the R-T characterstics of PTC device.

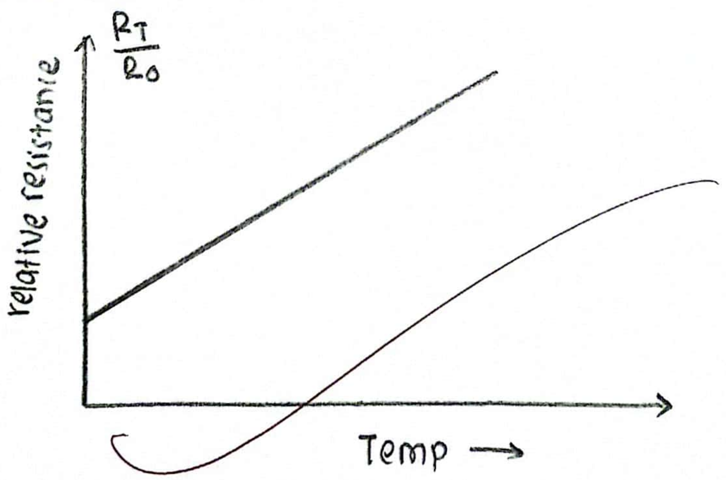
Apparatus required:

- Multimeter
- Electric water jug (kettle)
- PTC device
- power supply

Components required:

- jumper wires
-
-

Expected graph:



THEORY

Resistance Thermometer

Resistance thermometer or RTD operates upon the fact that almost all pure metals have the property of varying their resistance with temperature and the change in resistance is almost directly proportional to change in temperature. Thus electrical resistance with temperature for most metallic materials can be represented by an equation of the form;

$$R_T = R_0(1+\alpha t + \beta t^2 + \gamma t^3 + \dots + \omega t^n) \text{ ------ (i)}$$

where,

R_T = resistance at temperature T.

R_0 = resistance at 0° celsius

$\alpha, \beta, \gamma, \omega$ = temperature coefficient

In the narrow range of operation, β and higher order coefficients are negligibly small and therefore the expression for electrical resistance with temperature becomes,

$$R_T = R_0(1+\alpha t) \text{ -------- (ii)}$$

Observation:

$R_0 = 16.4\,\Omega$ $T_0 = 28°C$

S.No	Resistance (Ω) R_T	Temperature (°C)	$\frac{R_T}{R_0}$
1.	17.2	29	1.048
2.	17.3	34	1.054
3.	18.4	40	1.121
4.	21.1	46	1.286
5.	25.4	52	1.548
6.	35.2	58	2.146
7.	57.3	61	3.49
8.	75.3	68	4.591
9.	155.5	73	9.481
10.	213.9	76	13.042

Now,

Let, R_T be $25.4\,\Omega$ and T_1 be $52°C$.

Now,

$$R_T = R_0(1 + \alpha \Delta T)$$

$$R_T = R_0(1 + \alpha(T_1 - T_0))$$

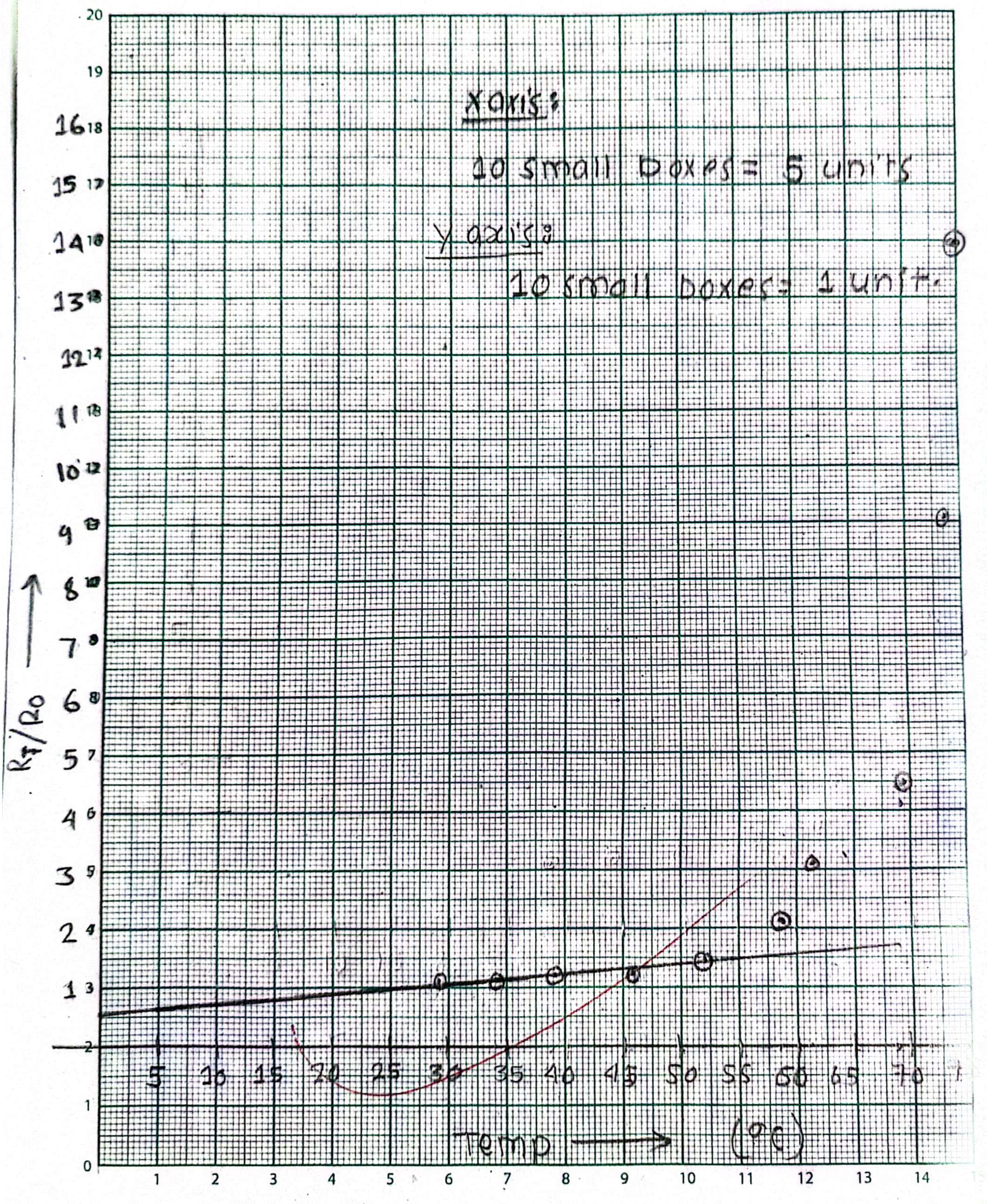
or, $25.4 = 16.4(1 + \alpha(52 - 28))$

or, $25.4 = 16.4 + 193.6\alpha$

or, $9 = 193.6\alpha$

or, $\alpha = 0.0464\ °C^{-1}$

SUB/REF ____________ NO ____________ DATE



Procedure:

Firstly, A PTC devic is taken and dipped it into the distilled water kept in the kettle. Then a thermometer is also dipped in the water. The initial resistance and initial temperature were measured and noted as R_0 and T_0. Then the kettle is started heating by giving voltage to it. After one minute, the resistor of PTC and temperature in thermometer is also noted. Then this was repeated till 10 times in each 1 minutes.

Finally the ratio between R_T and R_0 was calculated and plotted in the graph between temperature versus $\frac{R_T}{R_0}$. The obtained graph was found to be linear in nature.

RESULTS:

The linear expansivity of the resistance was found to be $0.04164\,°C^{-1}$ and the R-T characterstics was determined.

Conclusion:

The R-T characterstics ~~was~~ of PTC device was studied through this experiment and the graph between T and R_T/R_0 was found linear in nature.

NEPAL COLLEGE OF INFORMATION TECHNOLOGY

Balkumari Lalitpur

(Affiliated to Pokhara University)

A Lab Report

On

Subject: - Instrumentation.

Initial Checked

Lab Report #. 5

Title: - Determination of R-T characteristics of Thermister

Submitted By:

Name: - Niraj Bhatta

Roll No.: - 231326

Faculty: - BE. comp.

Year/Semester: - 2nd sem

Submitted To:

Instructor I: - Umang sir

Department of

Electrical & Electronics department.

Submission Date: - 2081-03-11

Experiment no: 5

THERMISTER

Objective:

- TO study the R-T characterstics of NTC device

APPARATUS REQUIRED:

- power supply
- Multimeter
- Electric Kettle
- NTC arrangement
- Jumper wires

THEORY:

Thermistor or thermal are semi-conductor device having negative temperature coefficient of resistance. It's resistance change with temperature that is their resistance decreases with increase in temperature. Thermister has non-linear characterstics and the resistance of thermister at any temperature can be expressed as;

$$R_T = R_0 e^{\beta\left(\frac{1}{T} - \frac{1}{T_0}\right)}$$

Where,

R_T = resistance of temperature T

R_0 = resistance of temperature T_0

β = experimentally determined constant.

OBSERVATION:

$R_0 = 0.467\ k\Omega$ $T_0 = 30^\circ C$

S.N.	Resistance (kΩ)	Temperature (°C)	R_T/R_0
1.	0.466	31	0.9978
2.	0.465	36	0.9957
3.	0.463	42	0.9914
4.	0.464	49	0.9935
5.	0.463	55	0.9914
6.	0.462	60	0.9892
7.	0.462	65	0.9892
8.	0.462	70	0.9892
9.	0.461	75	0.9871
10.	0.461	80	0.9871

Calculation of the constant value (B):

By observing no. 5 exp.

$$R_T = R_0\, e^{\beta\left(\frac{1}{T} - \frac{1}{T_0}\right)}$$

$$0.463 = 0.467\, e^{\beta\left(\frac{1}{55} - \frac{1}{30}\right)}$$

or, $0.99143468 = e^{\beta(-0.0151515)}$

or, $\ln(0.99143468) = \beta \cdot (-0.0151515)$

or, $\beta = 0.567600\ ^\circ C^{-1}$

ans#.

PROCEDURE:

Firstly, A NTC arrangement (with resistor) is taken and dipped into the distilled water kept in the kettle. Then with the help of multimeter and thermometer, the initial conditions (i.e R_o and T_o) were noted. Then power supply was given to the watter kettle and The increasing value of Temperature and decreasing value of resistor was noted. The experiment was done for 10 times keeping gap of 1 minutes in each data reading process.

Finally the value of experimentally calculated constant (B) was calculated and ~~plote~~ kept in the report.

RESULTS:

The experimentally calculated constant (B) was found to be $0.567600\ ^\circ C^{-1}$.

CONCLUSION:

The value of experimentally calculated constant (B) was calculated considering the R-T nature of the NTC device.