Lab Manual

for

PHY 112 (Basic Physics Lab)

Credit: 1, Contact Hour: 2 Hours Per Week

Department of Computer Science & Engineering
Varendra University
Rajshahi, Bangladesh

Varendra University

Department of Computer Science & Engineering

PHY 112

Basic Physics Lab

Student ID	
Student Name	
Section	
Name of the Program	
Name of the Department	

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INSTRUCTIONS FOR LABORATORY

1. You should arrive punctually.
2. Mobiles must be switched off.
3. Experiments will be performed in group. Stay with the same group throughout the semester, otherwise problem will arise in allocating you experiments.
4. Attendance is compulsory. Absence for some reasons should be notified in advance to the instructor.
5. Handle instruments with care. Report any breakage or faulty equipment to the Instructor.
6. Come equipped with calculator and other materials related to lab works.
7. You are required to record your observations in a hardback laboratory notebook. Each student will maintain his/her laboratory notebook. You must get at least one observation of each kind checked and signed by your instructor.
8. You must complete all experimental work during the two hours session. Every observation made must be recorded directly on the laboratory notebook. No rough record is allowed.
9. You are required to submit the complete report in your next laboratory session.

Varendra University, Rajshahi

COURSE SYLLABUS

<table>
<tr><td>1</td><td>Faculty</td><td colspan="2">Faculty of Science & Engineering</td></tr>
<tr><td></td><td>Department</td><td colspan="2">Computer Science and Engineering</td></tr>
<tr><td></td><td>Program</td><td colspan="2">B.Sc. in CSE</td></tr>
<tr><td></td><td>Name of Course</td><td colspan="2">Basic Physics Lab</td></tr>
<tr><td></td><td>Course Code</td><td colspan="2">PHY 112</td></tr>
<tr><td></td><td>Trimester and year</td><td colspan="2">Summer 2019</td></tr>
<tr><td></td><td>Prerequisite</td><td colspan="2">--</td></tr>
<tr><td></td><td>Status</td><td colspan="2">Additional Course</td></tr>
<tr><td></td><td>Credit hours</td><td colspan="2">1</td></tr>
<tr><td></td><td>Section</td><td colspan="2">A</td></tr>
<tr><td></td><td>Class hours</td><td colspan="2">2 hours</td></tr>
<tr><td></td><td>Class Locations</td><td colspan="2">DEL Lab</td></tr>
<tr><td></td><td>Course Website</td><td colspan="2">--</td></tr>
<tr><td></td><td>Instructor(s)</td><td colspan="2">Md. Nahid Hasan, Sumaia Rahman</td></tr>
<tr><td></td><td>Contact</td><td colspan="2">nahid@vu.edu.bd, Sumaia@vu.edu.bd</td></tr>
<tr><td></td><td>Office</td><td>Md. Nahid Hasan
Lecturer
Dept. of CSE
Engineering Annex Buildings.
Room No: 103</td><td>Sumaia Rahman
Lecturer
Dept. of CSE
Engineering Old Buildings.
Room No: 303</td></tr>
<tr><td></td><td>Counseling hours</td><td>Tuesday 09:00-10:30,
Wednesday 10.00:11:30</td><td>Thursday 09:00-10:30,
Sunday 10.00:11:30</td></tr>
<tr><td></td><td>Text book</td><td colspan="2">• “A text book of electrical Technology ” by B.L Theraja. A. K. Theraja</td></tr>
<tr><td></td><td>Reference</td><td colspan="2">https://www.quora.com</td></tr>
<tr><td></td><td>Equipments and Aids</td><td colspan="2">• Lab Sheet
• Text book</td></tr>
<tr><td></td><td>Course Description</td><td colspan="2">This is a laboratory course in elementary physics. The course will include selected experiments in resistance measurement, equivalent resistance of a circuit, current and Voltage measurement of a circuit. The laboratory portion of this course provides students with the opportunity to develop skills in the operation of basic electronics test instruments (dc power supply,</td></tr>
</table>

		digital multi-meter etc). Students will work in groups of two or more to perform and complete laboratory exercises.			
	Course objectives	• Develop knowledge and understanding the use of basic electronic equipments • Measurement techniques of basic electronic equipments • Design and draw basic electronic circuit in bread- Board • Verify the I-V Characteristics of a circuit. • Measure branch current and voltage of a circuit.			
	Learning Outcomes	I. Perform the comparison of resistance measurement using color code and multi-meter. II. Demonstrate the equivalent resistance of different series and parallel combination III. Show amount current and voltage of different circuits with series, parallel combination of resistance.			
	Teaching Methods	Lecture, Problem Solving, Q/A			
	Topic Outline				
	Class	**Topics**	**CLOs**	**Reading**	**Activities**
	1	Basic Electronic Equipment	I		Q/A
	2-3	Measure and Calculate resistance using color Code	I		Problem Solving , QA
	4-5	Calculate Equivalent resistance	II		Problem Solving , QA
	6-7	Measure I,V& verify I-V Characteristics	III		Problem Solving , QA
	8-9	Branch Current and Voltage measurement	III		Problem Solving , QA
	10	Lab Practice	--		-----
	11	Lab QUIZ	I,III		-----
	12	Final Lab Test	I,II,III		-----
	Assessment Methods	❖ Attendance (10%) ❖ Quiz Test (30%) ❖ Lab Viva/Presentation (10%) ❖ Lap Report (LR) (20%) ❖ Lab Test (LT) (30%)			
	Grading policy	(see table below)			

Letter Grade	Marks	Grade points
A+	80-100	4.00
A	75-79	3.75
A-	70-74	3.5

			B+	65-69	3.25	
			B	60-64	3.00	
			B-	55-59	2.75	
			C+	50-54	2.5	
			C	45-49	2.25	
			D	40-44	2.00	
			F	<40	0.00	

	Additional Course Policies	**1. 1. Lab Reports** Report on previous Experiment must be submitted before the beginning of new experiment. A bonus may be obtained if a student submits a neat, clean and complete lab report. **2. 2. Examination** There will be a lab exam at the end of the semester that will be closed book. **3. 3. Unfair means policy** In case of copying/plagiarism in any of the assessments, the students involved will receive zero marks. Zero Tolerance will be shown in this regard. In case of severe offences, actions will be taken as per university rule. **4. 4. Counseling** Students are expected to follow the counseling hours posted. In case of emergency/unavoidable situations, students can e-mail me to make an appointment. Students are regularly advised to check the piazza course page for updates/materials. **5. 5. Policy for Absence in Class/Exam** If a student is absent in the class for anything other than medical reasons, he/she will not receive attendance. If a student misses a class for genuine medical reasons, he/she must apply with the supporting documents (prescription/medical report). He/she will then have to follow the instructions given by the instructor for makeup. In case of absence in the mid/final exam for medical grounds, the student must also get his/her application forwarded by the head of the department before a make-up exam can be taken. It is recommended that the students inform the instructor beforehand through mail if they feel that they will miss a class/evaluation due to medical reasons.

Lab No.: 1

Basic Electronics Instruments

Resistor: A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit. Resistors can also be used to provide a specific voltage for an active device such as a transistor.

Figure 1: Resistor

Resistance: Resistance is a measure of the opposition to current flow in an electrical circuit. Resistance is measured in ohms, symbolized by the Greek letter omega (Ω).

Multi-meter: The multi-meter provides conveniently in a single instrument a number of ranges of measurement of voltage (DC/AC), current and resistance. It is necessary to select the appropriate quantity and range as well as the proper connections for the two input leads. The AC ranges are distinguished from the DC ranges by the symbol (~).

Figure: Multi-meter

Ammeter: The meter uses for measuring the current is known as the ammeter. The current is the flow of electrons whose unit is ampere. Hence the instrument which measures the flows of current in ampere is known as ampere meter or ammeter.

The ideal ammeter has zero internal resistance. But practically the ammeter has small internal resistance. The measuring range of the ammeter depends on the value of resistance.

Figure 2: Ammeter

Bread-board: A white board with holes that allow circuits, wires, and other components to be interconnected without soldering. A breadboard is a widely used tool to design and test circuit.

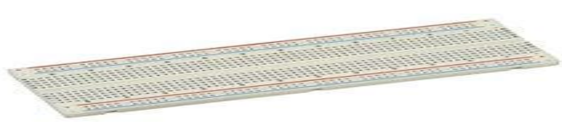


Figure 3: Bread-board

Lab No.: 2

Resistance and Color Code

Resistance color coding: The electronic color code is used to indicate the values or ratings of electronic components, very commonly for resistors, but also for capacitors, inductors, and others. To distinguish left from right there is a gap between the C and D bands. See Fig.

- Band A is first significant figure of component value (left side).
- Band B is the second significant figure (Some precision resistors have a third significant figure, and thus five bands.)
- Band C is the decimal multiplier.
- Band D if present, indicates tolerance of value in percent (no band means 20%).

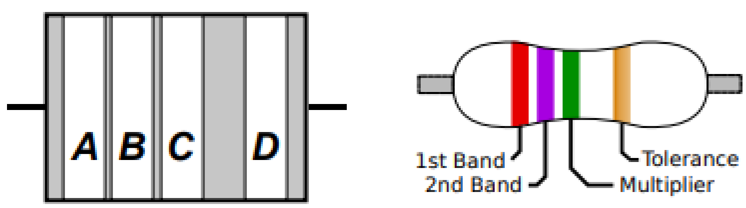


Figure: 4 band resistor

The standard color code is shown in Table 1

Sl.	Color	Significant Value	Tolerance
1	Black	0	--
2	Brown	1	±1%
3	Red	2	±2%
4	Orange	3	--
5	Yellow	4	±5%
6	Green	5	±0.5%
7	Blue	6	±0.25%
8	Violet	7	±0.1%
9	Gray	8	±0.05%
10	White	9	--

11	Gold	--	x10^{-1}	±5%
12	Silver	--	x10^{-2}	±10%
13	None	--	--	±20%

Table 1: Resistor color coding. A mnemonics to remember the color codes of electronic components in resistors is**: B B ROY G**ood **B**oy **V**ery **G**ood **W**orker

Calculate the resistance: using the above table the resistance of a resistor is calculated by the following formula

$$R = AB \times 10^{C} \pm D$$

Table:

Sl.	Resistor	Color Code	Calculated value

Lab No.:3

Measurement of resistance

One important measurement that can be made with a multi-meter is a resistance measurement. Measuring resistance with a digital multi-meter is easier and faster than making a resistance measurement with an analogue multi-meter.

There are a few simple steps required to make a resistance measurement with a digital multi-meter:

1. Select the item to be measured: This may be anything where the resistance needs to be measured and estimate what the resistance may be.
2. Insert the probes into the required sockets. Often a digital multi-meter will have several sockets for the test probes. Insert these or check they are already in the correct sockets. Typically these might be labeled COM for common and the other where the ohms sign is visible. This is normally combined with the voltage measurement socket.
3. Turn on the multi-meter
4. Select the required range. The digital multi-meter needs on and the required range selected. The range selected should be such that the best reading can be obtained. Normally the multi-meter function switch will be labeled with the maximum resistance reading. Choose the one where the estimated value of resistance will be under but close to the maximum of the range. In this way the most accurate resistance measurement can be made.
5. Make the measurement with the multi-meter ready to make the measurement the probes can be applied to the item that needs to be measured. The range can be adjusted if necessary.
6. Turn off the multi-meter. Once the resistance measurement has been made, the multi-meter can be turned off to preserve the batteries. It is also wise to turn the function switch to a high voltage range. In this way if the multi-meter is used to again for another type of reading then no damage will be caused if it is inadvertently used without selecting the correct range and function.

Figure: *Resistance measurement using Digital Multi-meter*

Table:

Sl.	Resistor	Calculated value	Measured value

Lab No.: 4

Equivalent resistance of a circuit

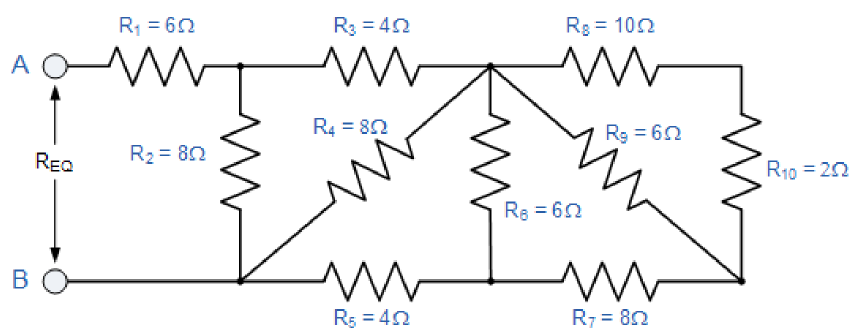
Series Circuit: A circuit is said to be series connected if all components are connected end-to-end to form only one path for the current to flow through the circuit:

Parallel Circuit: A circuit is said to be parallel connected all components are connected between the same two sets of electrically common points, creating multiple paths for the current to flow from one end of the battery to the other:

Combination Circuit: A "COMBINATION CIRCUIT" is a circuit that is a blend of series paths and parallel paths.

Equivalent resistance: In a given combination of resistors (series, parallel, or combination of series/ parallel), the equivalent resistance is that value of resistance, which when replaced in place of the combination, will continue to give the same performance for the part of circuit outside this combination

Calculation:



Solution:

First using R_8 and R_{10} resistors, these two resistors are in series so we get from equ. No. (1)

$R_s = R_1 + R_2$ ………………………………. (1)

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ …………………………………….. (2)

$R_{8,10} = R_8 + R_{10}$ = 10Ω+2 Ω = 12 Ω

Now Using $R_{8,10}$ and R_9 resistors, these two resistors are in parallel so we get from equ. No. (2)

$\frac{1}{R_p} = \frac{1}{R_9} + \frac{1}{R_{8,10}}$ => $\frac{1}{R_p} = \frac{1}{6} + \frac{1}{12}$

So, R_p= $R_{8,9,10}$= 4 Ω

Using $R_{8,9,10}$ and R_7 resistors, these two resistors is in series, so we get from equ. No. (1),

$R_{7,8,9,10} = R_{8,9,10} + R_7$ = 4 Ω + 8 Ω =12 Ω

Using $R_{7,8,9,10}$ and R_6 resistors, these two resistors is in parallel , so we get from equ. No. (2),

$\frac{1}{R_{6,7,8,9,10}} = \frac{1}{R_{7,8,9,10}} + \frac{1}{R_6}$ so value of $R_{6,7,8,9,10}$ = 4 Ω

Using $R_{6,7,8,9,10}$ and R_5 resistors, these two resistors is in Series , so we get from equ. No. (1),

$R_{5,6,7,8,9,10} = R_{6,7,8,9,10} + R_5$ = 4 Ω + 4 Ω =8 Ω

Using $R_{5,6,7,8,9,10}$ and R_4 resistors, these two resistors is in parallel , so we get from equ. No. (2),

$\frac{1}{R_{4,5,6,7,8,9,10}} = \frac{1}{R_{5,6,7,8,9,10}} + \frac{1}{R_4}$ so value of $R_{4,5,6,7,8,9,10}$ = 4 Ω

Using $R_{4,5,6,7,8,9,10}$ and R_3 resistors, these two resistors is in series, so we get from equ. No. (1),

$R_{3,4,5,6,7,8,9,10} = R_{4,5,6,7,8,9,10} + R_3$ = 4 Ω + 4 Ω =8 Ω

Using $R_{3,4,5,6,7,8,9,10}$ and R_2 resistors, these two resistors is in parallel , so we get from equ. No. (2),

$\frac{1}{R_{2,3,4,5,6,7,8,9,10}} = \frac{1}{R_{3,4,5,6,7,8,9,10}} + \frac{1}{R_2}$ so value of $R_{2,3,4,5,6,7,8,9,10}$ = 4 Ω

Finally, using $R_{2,3,4,5,6,7,8,9,10}$ and R_1 resistors, these two resistors is in series , so we get from equ. No. (1),

$R_{1,2,3,4,5,6,7,8,9,10} = R_{2,3,4,5,6,7,8,9,10} + R_1$ = 6 Ω + 4 Ω =10Ω

Therefore, the equivalent resistance of the given circuit is 10Ω

Lab No.: 5

Measurement of Equivalent Resistance

Based on Lab-4 Students are draw a circuit on bread- board and measure the equivalence resistance using Multi-meter (ohm's meter)

Table:

Sl.	Resistors Value		Calculated value	Measured Value
	R1			
	R2			
	R3 …			

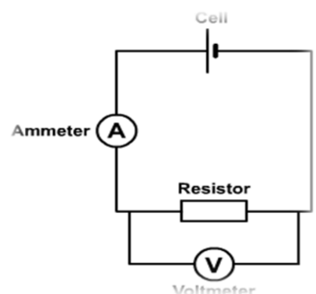
Result:

Lab No.: 6

Measure and calculate the circuit current and voltage

Current: Current is the rate at which electric charge flows past a point in a circuit. In other words, current is the rate of flow of electric charge. The current ranges are marked A. Current is measured through a component that is the meter is connected in series with the component (shown in the below figure). The meter displays the polarity of the current entering the A sockets.

Voltage: Voltage, also called electromotive force, is the potential difference in charge between two points in an electrical field. In other words, voltage is the energy per unit charge. The voltage ranges are marked V. Voltage is measured across a component, that is, the meter is connected in parallel with the component (shown in below figure). The meter displays the polarity of the voltage relative to the COM connection.



Circuit current I can be calculated using the following formula

$$V = IR$$

$I = V/R$ where R= Equivalence resistance of a circuit

V= Supply Voltage

Circuit Voltage V calculated using the following formula

Table: $V = IR$ where R is the resistance

Sl.	**Circuit Current**		**Resistor**	**Circuit voltage**	
	Measured Value	*Calculated Value*		*Measured Value*	*Calculated Value*

Lab No.: 7

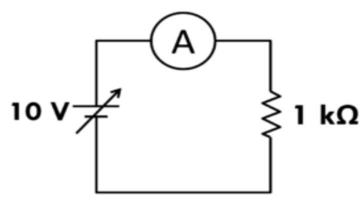
Verify the ohm's law

Ohm's Law: Georg Ohm found that, at a constant temperature, the electrical current flowing through a fixed linear resistance is directly proportional to the voltage applied across it, and also inversely proportional to the resistance. This relationship between the Voltage, Current and Resistance forms the basis of Ohms Law and is shown below.

$$Current, I = \frac{Voltage, V}{Resistance, R} \; in \; Amperes, A$$

By knowing any two values of the Voltage, Current or Resistance quantities we can use Ohms Law to find the third missing value. Ohms Law is used extensively in electronics formulas and calculations so it is "very important to understand and accurately remember these formulas".

Circuit Diagram:



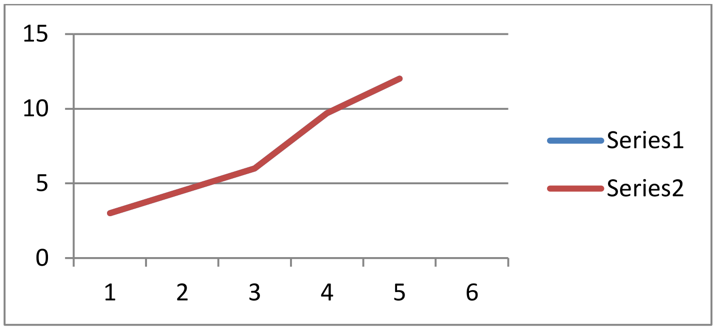
Steps:

1. Implement the circuit on the breadboard as shown in circuit diagram.
2. Initially set the VDC supply to 0 V and note the current on ammeter.
3. Increase the voltage to 1 V, observe the ammeter and note the readings.
4. Repeat the above step for 2 V, 3V … 10 V.
5. Plot a graph for measured readings.
6. Compare the plot with theoretical calculations.

Calculated Table:

Sl.	Voltage(V)	Resistance	Current(mA)
1			
2			
3			
4			
5			

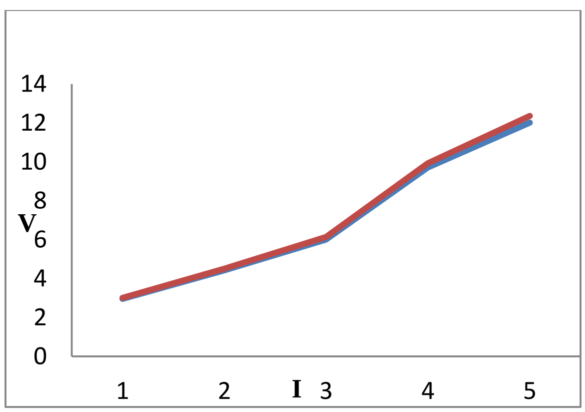
Graph with Calculated Value:



Measured Value:

Sl.	Ref. Volt	Resistance	Current

Graph with Measured Value:



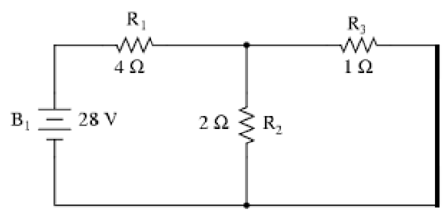
Result:

Lab No.: 8

Branch Current Measurement

Branch Current: The current through each branch of the network is called the branch current. Once the branch current is known, all other quantities, such as voltage or power can be determined. There are four steps to the branch current which are given below.

a) Assign a distinct current of arbitrary direction to each branch of the network.
b) Indicate the polarities for each resistor as determined by the assumed current direction.
c) Apply current divider law at the minimum number of nodes that will include all the branch currents of the network.
d) Solve the resulting simultaneous linear equations for assumed branch currents



Calculations:

We know that Circuit Current I= V/R

Now the equivalence resistance $R_{eq}= \{\frac{1}{R2} + \frac{1}{R3}\}+R_1$

Since R_2 and R_3 in parallel connection, so the equivalence resistance will be

$$R_p^{-1} = R_2^{-1}+R_3^{-1}$$

$$=3/2$$

$$R_p=0.667$$

R_p and R_1 are in Series Connection, So the equivalence resistance will be

$$R_{eq}= R_p+R_1$$

$$=0.667+4$$

$$=4.667\ \Omega$$

Then the circuit Current will be

$$I=V/R_{eq}$$

$$=28/ 4.667$$

$$=6 \text{ A}$$

Using Current divider rule we get

$$I_1 = \frac{I * R3}{R2 + R3}$$

I_1= 2 A

I_2= I-I_1

=6 -2

=4 A

Table:

Sl.	Volt	Total Current (I)		Branch Current (I1)		Branch Current(I2)	
		Measured Val.	Calculated Val.	Measured val.	Calculated val.	Measured val.	Calculated val.

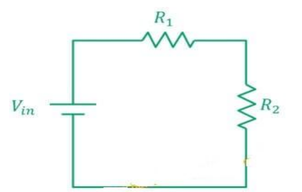
Result:

Lab No.: 9

Branch Voltage Measurement

Branch Voltage: In electric circuit's analysis, nodal analysis, node-voltage analysis, or the branch current method is a method of determining the voltage (potential difference) between "nodes" (points where elements or branches connect) in an electrical circuit in terms of the branch currents.

The circuit below displays a circuit with two resistors R_1 and R_2. The source V_{in} powers circuit

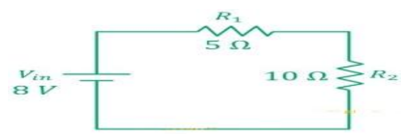


We are interested to determine the voltage which is dropped across both resistors. Let's consider V_1 is across dropped across R_1 and V_2 is across R_2. The formulas are:

$$\boldsymbol{V1 = \frac{R1}{R1+R2} * V_{\text{in}}}$$

$$\boldsymbol{V2 = \frac{R2}{R1+R2} * V_{\text{in}}}$$

Let's solve an example to better understand it



$$\boldsymbol{V2 = \frac{R2}{R1+R2} * V_{\text{in}}}$$

$$\boldsymbol{V2 = \frac{10\Omega}{10\Omega + 5\Omega} * 8}$$

$$\boldsymbol{V2 = 5.33V}$$

Sl	Measured Value(V)		Calculated Value(V)	
	R1	***R2***	***R1***	***R2***

Result:

Lab 10: Practice Lab

Lab 11: Lab Quiz

Lab 12: Final Lab Test