STUDENT NAME:	
TUTOR NAME:	**Dr. Ameer Al-khaykan**
PROGRAMME:	Electrical Circuit
SUBJECT:	Electrical and Electronics
COURSEWORK TITLE:	**Ohm's Law**

Issue Date:	Due Date:	Feedback Date:	Extension Date:

PERFORMANCE

TARGETED LEARNING OUTCOMES

4. Solve problems involving basic analogue and digital electronic circuits using numerical skills appropriate to an engineer.

5. Identify and safely use standard laboratory equipment to extract data, then apply in the solution of an electronic or electrical engineering problem;

6. Adopt a logical approach to the solution of engineering problems.

COURSEWORK WILL BE MARKED ACCORDING TO THE FOLLOWING UNIVERSITY CRITERIA.

90-100%: a range of marks consistent with a first where the work is exceptional in all areas;

80-89%: a range of marks consistent with a first where the work is exceptional in most areas.

70-79%: a range of marks consistent with a first. Work which shows excellent content, organisation and presentation, reasoning and originality; evidence of independent reading and thinking and a clear and authoritative grasp of theoretical positions; ability to sustain an argument, to think analytically and/or critically and to synthesise material effectively.

60-69%: a range of marks consistent with an upper second. Well-organised and lucid coverage of the main points in an answer; intelligent interpretation and confident use of evidence, examples and references; clear evidence of critical judgement in selecting, ordering and analysing content; demonstrates some ability to synthesise material and to construct responses, which reveal insight and may offer some originality.

50-59%: a range of marks consistent with lower second; shows a grasp of the main issues and uses relevant materials in a generally business-like approach, restricted evidence of additional reading; possible unevenness in structure of answers and failure to understand the more subtle points: some critical analysis and a modest degree of insight should be present.

40-49%: a range of marks which is consistent with third class; demonstrates limited understanding with no enrichment of the basic course material presented in classes; superficial lines of argument and muddled presentation; little or no attempt to relate issues to a broader framework; lower end of the range equates to a minimum falls short in one or more areas.
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35-39%: achieves many of the learning outcomes required for a mark of 40% but falls short in one or more areas.

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30-34%: a fail; may achieve some learning outcomes but falls short in most areas; shows considerable lack of understanding of basic course material and little evidence of research.

0-29%: a fail; basic factual errors of considerable magnitude showing little understanding of basic course material; falls substantially short of the learning outcomes for compensation.

Note:

- While constructing circuits all connects should be made with the power supply in the off position.

- Check power and ground connections (and other connections) **before** switch on the power.

- Make sure that the power and the ground are properly connected to all IC's before switch on the power.

- **DO NOT** strip wire ends longer than 1/4" and jam long bare ends into the breadboard holes. This will cause shorts and ruin the board.

- **DO NOT** short (connect) the power supply outputs together, i.e., do not allow the exposed wires to touch each other. This will cause permanent damage to the power supply.

- **DO NOT** connect the power supply to the breadboard with reverse polarity. This will cause the permanent chip damage.

- **DO NOT** connect an output of any gate to the output of another gate, to a switch, to power (+5V), or to ground. These situations will cause excessive currents and result in the permanent damage to the chip or chips involved.

1.1. Objects

- To get familiar with Ohm's law implementation in electric circuits, moreover, voltage-current measurements, network reduction, transformation and power supplied and consumed calculations are among other electrical engineering principles a student should a quire.

1.2. Apparatus:

- Resistors (different ratings)
- (D.C) power supply
- Measuring instruments (voltmeter, ammeter and ohmmeter)
- Connecting wires and board.

1.3. Theory :

In 1826 George Ohm published a paper, in which his measurements of electricity were summarized in a simple relation between current and voltage, using a constant that we call the resistance of the circuit.

Ohm's Law relates the current (I) through a conducting material to the voltage (V) across its ends by:

$$V = R * I ....(1.1)$$

R Is called the resistance of the material. For metals and most other conductors, R is constant, that is, it is not dependent on the amount of current. In some materials "semiconductors" R is not constant, and this fact is useful in vast electrical applications.

Considering D.C quantities, if V is the potential difference across a resistor R and I is the current through it, then

$$V = R * I ....(1.2)$$

Equation (1.2) is that of a straight line passing through the origin see Fig

(1-1). It is obvious that the slope of the line is the resistance R , i.e.

$$slop = \frac{S_v \Delta V (volt)}{S_i \Delta I (Amp)}$$

$$= K \tan(\Phi)$$

where, S_v = scale factor for the V -axis $\left(\dfrac{V}{cm} \right)$

S_i =scale factor for the I -axis $\left(\dfrac{Amp}{cm}\right)$

K =scale ratio

Many electric circuits and devices or elements do have non-linear $V - I$ characteristics, i.e. not as smooth and straight as that shown in Fig (1-1). Fig (1-2) exemplifies such characteristics.

In none of the examples shown in Fig (1-2) does a single linear resistor approximate the shape of the curve.

Therefore, such characteristics can be obtained experimentally. Analyzing circuits containing such non-linear elements mathematically requires a sort of approximations in representing the $V - I$ characteristics by functions. Of such approximations is the curve fitting technique. As an example, consider the filament lamp characteristics of Fig (1-3)

Approximate the characteristics for all values of V and I greater than zero by two straight lines, one can write the following two equations for such piecewise linear approximation.

$$V = \frac{V_1}{I_1} I, \qquad for 0 < I < I_1 (line1)..........(1.4)$$

and

$$V = \frac{V_2}{I_2} I, \qquad for I > I_1 (line2)............(1.5)$$

Using the approximated linear equation in circuit analysis yields approximate solution. In order to obtain a more accurate result, graphical method is worthy considering.

In linear circuits, if resistors of resistance $R_1, R_2, R_3.........etc.$ are connected in series see Fig (1-4a), the total equivalent resistance R is given by:

$$R = R_1 + R_2 + R_3.......... + R_n..............(1.6)$$

If linear circuits are connected in parallel, see Fig (1-4b). The total equivalent resistance R is given by:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots\dots + \frac{1}{R_n} \dots\dots\dots(1.7)$$

With regard to energy, electric circuits and system do follow the law of conservation of energy. In other words, the sum of energy generated by the sources equal to sum of energy consumed in the elements of the circuit(s).

Consider Fig (1-5) if V represents the potential difference in volts across a circuit or an element having resistance R in Ohms, carries a current I in Amperes, supplied from a voltage source of E volts then:

$$P_{consumed}(Watts) = V*I = I^2*R = \frac{V^2}{R} \dots\dots\dots(1.8)$$

$$P_{supplied}(Watts) = E*I \dots\dots\dots(1.9)$$

and

$$P_{consumed} = P_{supplied}$$

This figure shows Ohm's Laws:

P = power

V^2/R $R \times I$ V = voltage

$R \times I^2$ P/I

$V \times I$ watts P | volts V $\sqrt{P \times R}$

$\sqrt{\dfrac{P}{R}}$ I amps | R ohms $\dfrac{V}{I}$

$\dfrac{P}{V}$ $\dfrac{V}{R}$ $\dfrac{P}{I^2}$ $\dfrac{V^2}{P}$

I = current

R = resistance
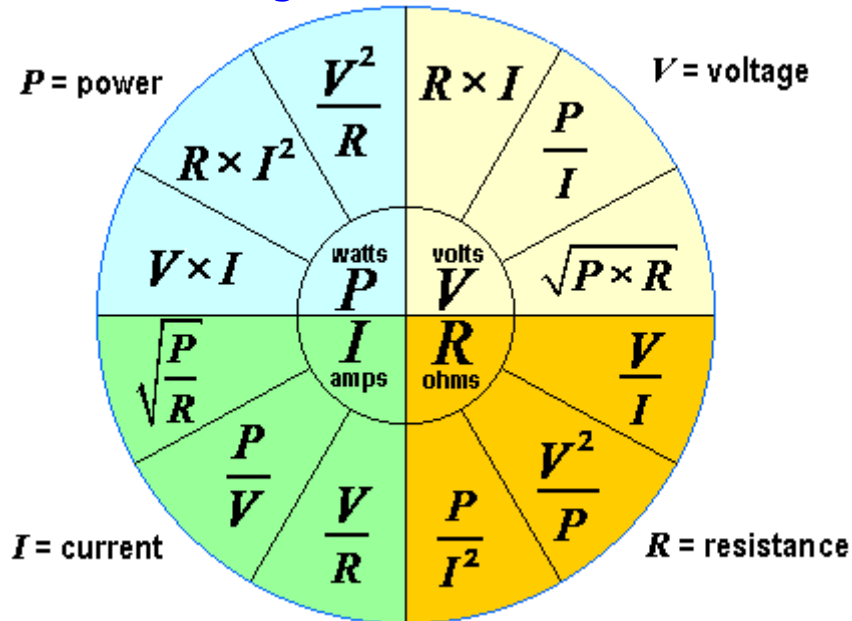
1.4. <u>Procedure:</u>

- Connect the circuit shown in Fig (1-6).
- Vary the supply voltage source in rang (E=0 to $10V$) volts in step $2V$ a cross ab terminals and make record of the current in each case as shown in table   (1-1).
- Connect the circuit shown in Fig (1-7).
- Vary the resistance value of R_2 in range (100 to $500\,\Omega$) in step $100\,\Omega$; make record of the current in each case as shown in table (1-2).

1.4.2. <u>Resistance Measurements:</u>

- Connect the circuit shown if Fig (1-9)
- Use the ohmmeter to measure the equivalent resistance R_{ab} in each case.
- For the same combinations of resistors of Fig (1-10) use voltage source (E=5-20V) across ab terminals and make a record of the supply current, (two readings in each case)
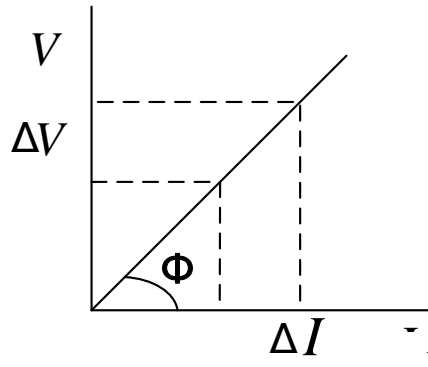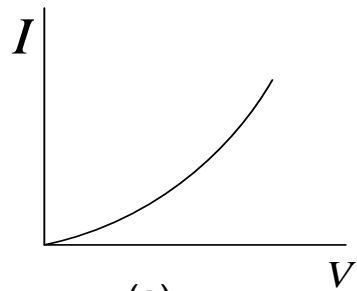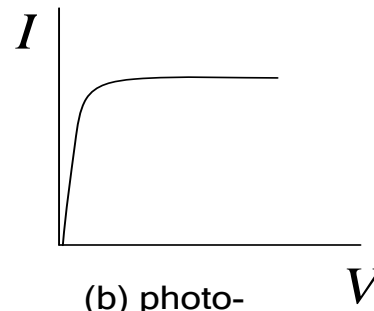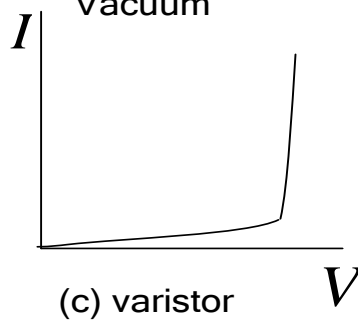- Find R_{ab} and comment on results.

Fig (1-1)

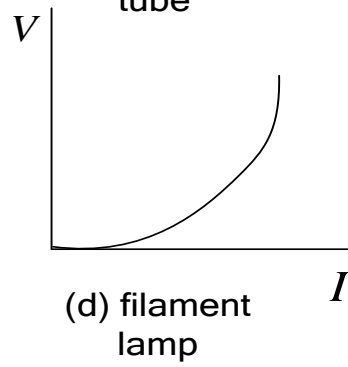

(a) Vacuum
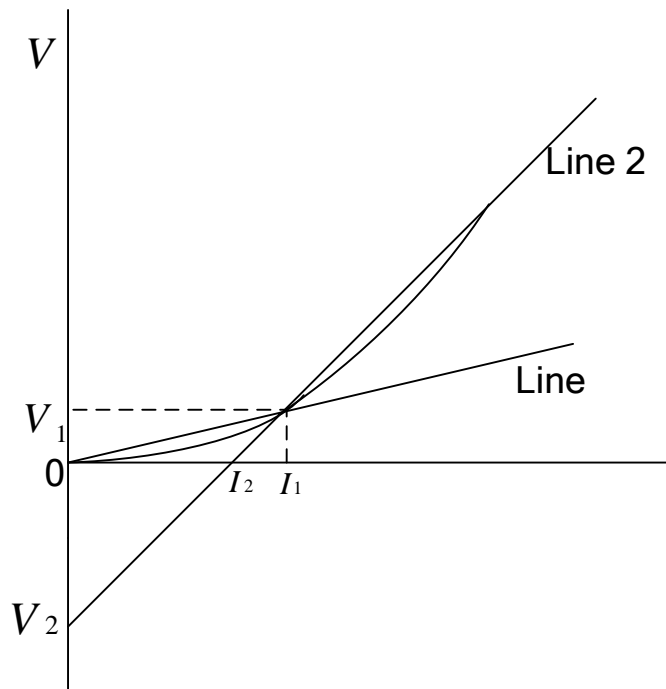
(b) photo-tube
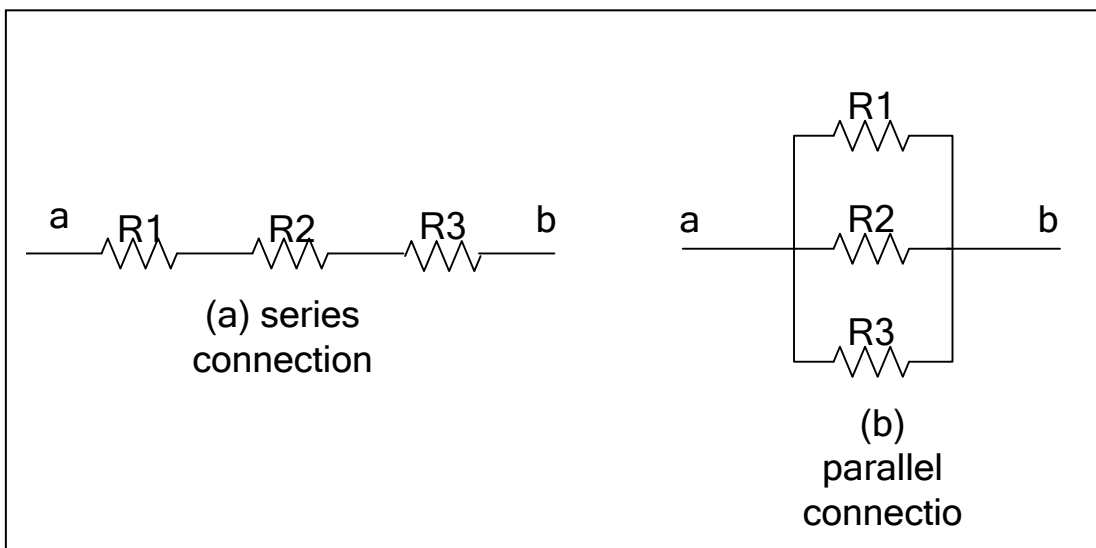
(c) varistor

(d) filament lamp

Fig (1-2)

Fig (1-3)

(a) series connection

(b) parallel connectio

Fig. (1 – 4)
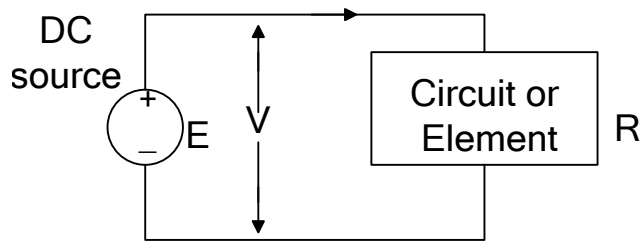
Fig (1-5)

E(volts)	Current (mA)
0	
2	
4	
6	
8	
10	

Table (1-1)
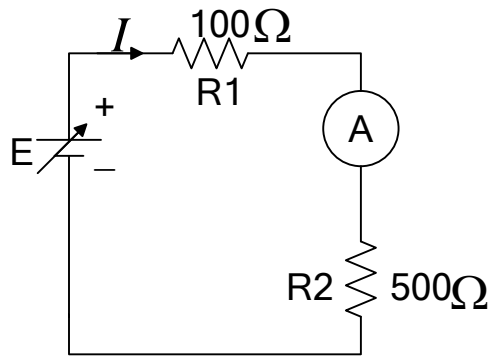
Fig (1-6)

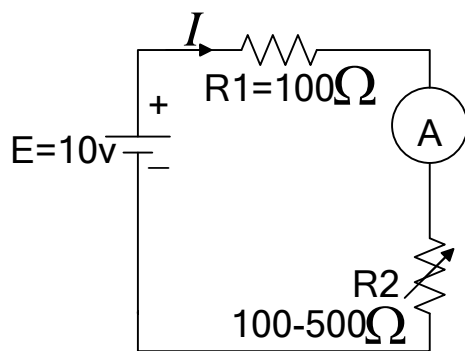| R2 (Ω)	Current (mA)
100	
200	
300	
400	
500	

Fig (1-7)
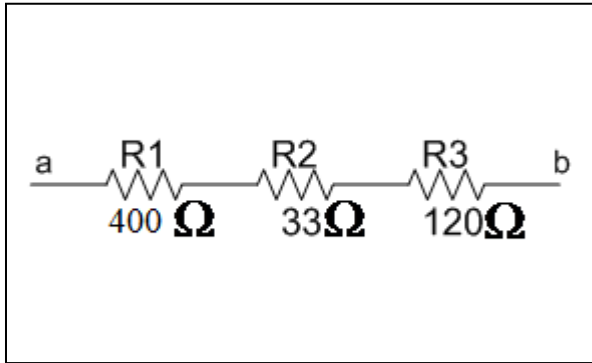
Fig (1-8)
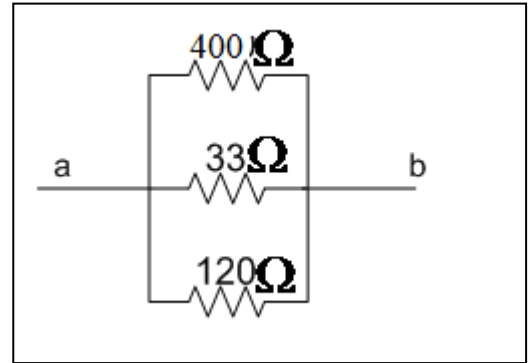
Fig (1-9)

Resistor	Nominal Value(Ω)	Measured Value	Measured Different	Specified Tolerance (%)	Comment
1					
2					
3					

Table (1-4)

1.5. Discussion:

1. Comment on your measurements.

2. Why the shunt resistor of the ammeter is low?

3. Why the series resistor of the voltmeter is high?

4. Draw and explain all (V - I) characteristics of your measurements.

5. A 30 Ω and 40 Ω resistors are connected in parallel then connected in series with 50 Ω resistors and 15 V voltage source forming a closed circuit. Find R_{equ} for this circuit then find I_T .

6. The circuit shown in Fig (1-1), calculates R_{equ}, V_{ab}, I_2, $P_{supplied}$ and $P_{consumed}$ across $30\,\Omega$ resistor.
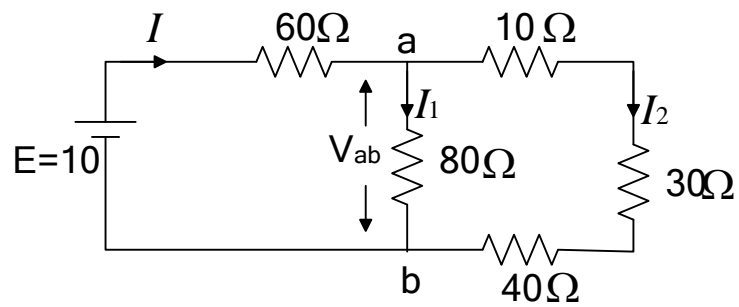

Fig (1-11)