Eastern Mediterranean University
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Department of Electrical and Electronic Engineering

INFE 221

Electrical Circuits

Third Lab Session

Resistive Circuits and Fundamental Laws (2)

Theory of Voltage and Current Division and the Concept of Electrical Power

Student Name	***Student Number***
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Objective:

1- To investigate the Concept of Electrical Power and Power Transfer.

2- To explore the Theory of Voltage and Current Division.

Theoretical Section

1- The Concept of Electric Power and Power Transfer

In an electric circuit, the Power is the time rate of expending or absorbing energy, measured in watts (W)

$$P = \frac{dw}{dt} = \frac{dw}{dq} \cdot \frac{dq}{dt} = v.i = i^2R \qquad (1)$$

Whether the power supplied or absorbed by an element, is the product of the voltage across the element and the current through it. The Power displays timevarying property according to the equation (1) and sometimes called instantaneous power. The sign of the power is very essential matter, if the power has positive sign means that the power being absorbed by the element. On the other hand, if the power has negative sign, the power being supplied by the element. Current direction and voltage polarity play a major role in determining the sign of power.

The ***Passive sign convention*** states that the voltage polarity and current direction must conform in order for the power to have a positive sign. In other words, the electric current should enters through the positive polarity of the voltage. In this case, $P = +vi$ implies that the element absorbing power. In contrast, if $P = -vi$ the element is supplying power.

2- Series Resistors and voltage division

The equivalent of any number of resistors connected in series is the sum of the individual resistances

For N resistors in series, the equivalent resistance is as follow

$$R_{eq} = \sum_{n=1}^{N} R_n$$

If 2 Resistors connected in series with the source voltage v, as in the following circuit, the resistors R_1 *and* R_2 have a voltage drop as follow

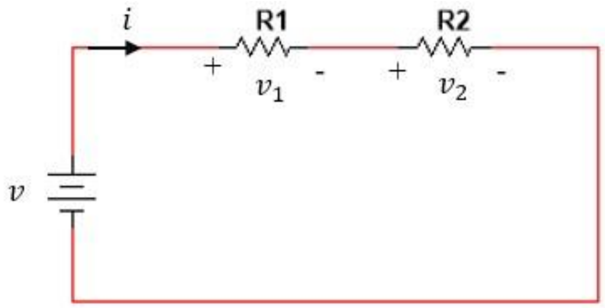

Figure (1): two resistors connected in series with voltage source

$$v_1 = \frac{R_1}{R_1 + R_2} v$$

$$v_2 = \frac{R_2}{R_1 + R_2} v$$

If N Resistors connected in series with the source voltage v, the n^{th} resistor R_n will have a voltage drop of

$$v_n = \frac{R_n}{R_1 + R_2 + \cdots + R_N} v$$

3- Parallel Resistors and current Division

Given the circuit in the subsequent figure, the equivalent resistance of two parallel resistors is equal to the product of their resistances divided by their sum

$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$$

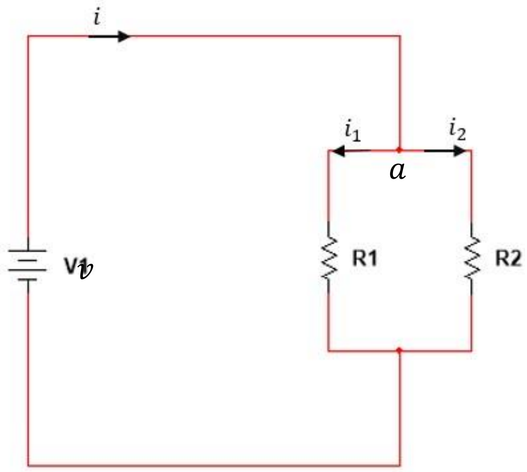

Figure (2): Two parallel connected resistors and voltage source

Given the total current i entering the node a, we can obtain the current i_1 and i_2 as follow

$$i_1 = \frac{v}{R_1} = \frac{R_{eq}\, i}{R_1} = \frac{\frac{R_1 R_2}{R_1 + R_2}\, i}{R_1} = \frac{R_2}{R_1 + R_2}\, i$$

$$i_2 = \frac{v}{R_2} = \frac{R_{eq}\, i}{R_2} = \frac{\frac{R_1 R_2}{R_1 + R_2}\, i}{R_2} = \frac{R_1}{R_1 + R_2}\, i$$

The general case of the equivalent resistors in a circuit with N resistors in parallel is as follow

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}$$

It is more convenient to use conductance rather than resistance when dealing with resistors in parallel. The equivalent conductance of N resistors in parallel is the sum of their individual conductance.

$$G_{eq} = G_1 + G_2 + \cdots + G_N$$

Where $G_{eq} = 1/R_{eq}$, $G_1 = 1/R_1$, $G_2 = 1/R_2$ and $G_N = 1/R_N$

In general, if a current i divided into N branches, each branch has resistor R_n, we can find the current passing through each branch by the following equation

$$i_n = \frac{G_n}{G_1 + G_2 + \cdots + G_N} i$$

Practical Section

1- Construct the following circuit, measure i and fill the table (1)

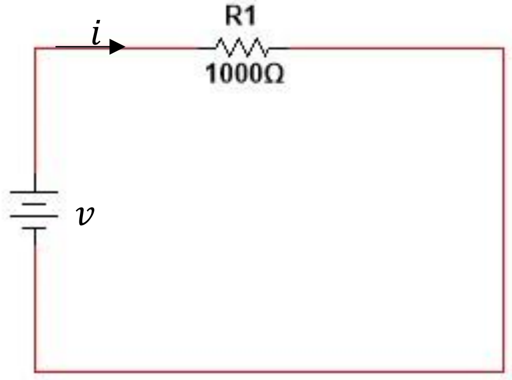

Table (1)

Voltage (V)	Current (mA)	Power (mW)
2		
4		
6		
8		
10		

2- Construct the following Circuit, measure i and fill the table 2 and table 3

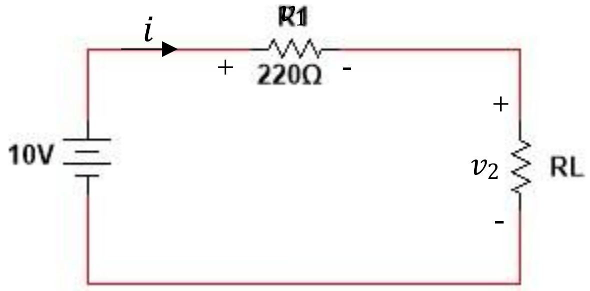

Table (2)

Load Resistance R_L (ohms)	Current i (mA)	Power i^2R_l (mW)
100		
220		
1000		
2000		
2200		

Table (3)

Load Resistance R_L (ohms)	Voltage v_1 $(Volt)$	Voltage v_2 v_2 $(Volt)$
100		
220		
1000		
2000		
2200		

3- Construct the following circuit, measure i, i_1, i_2, i_3 and fill the table (4)

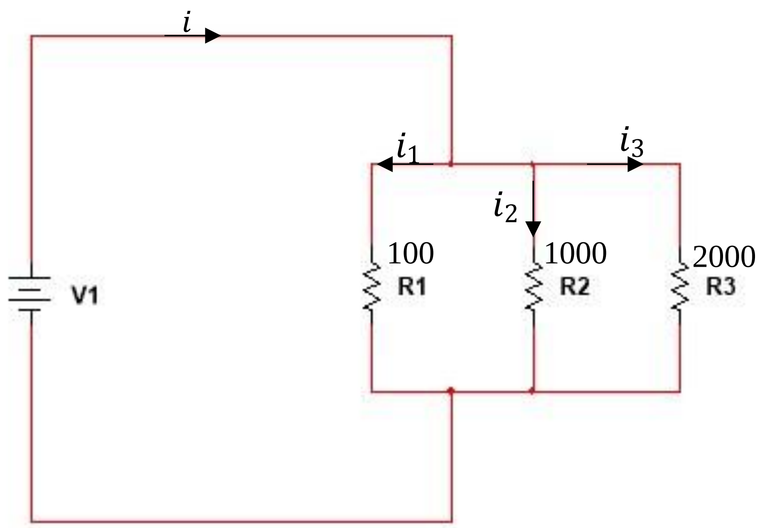

Table (4)

Voltage (V)	Current i (mA)	Current i_1 (mA)	Current i_2 (mA)	Current i_3 (mA)
2				
4				
8				