Eastern Mediterranean University

"For Your International Career"

Department of Electrical and Electronic Engineering

INFE 221

Electrical Circuits

First Lab Session

Constructing Electrical Circuit concerning Resistors and Voltage Source

Student Name **Student Number**

…… **……**

OBJECTIVE: To become familiar with interpreting circuit diagrams and reading electric meters when the circuit is switched on.

Theoretical Review

The Students are asking to read the following section or the course Textbook first chapter before attending this session.

1. Electric Charge and Electric Current

Charge is the most basic quantity in electric Circuits that leads to explain all electric phenomena. All of us know that everything is made of fundamental blocks called atom. Each atom contains Charged particles, positive protons and negative electrons. Generally, there's an equal number of each, meaning the net electric charge of the atom is 0.

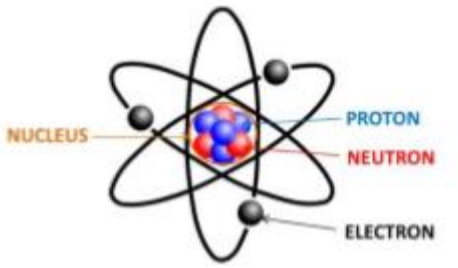


Figure 1: Solid Material Atom Construction

In solid materials. Protons stay fixed, but some electrons are free to move around. These moving electrons are called free electrons. Materials that are conductors, like copper, let the free electrons move freely throughout the solid, while insulators, like wood, hold on to them tightly, limiting their flow.

When a conducting wire is connected to an outside force, like battery, the free electrons plucked off and carried around. This motion of free electrons creates electric current. It's important to know that no new charges were created or destroyed during this process only transferred from one position to another. It is conventional to take the electric current unlike the flow of the electrons flow.

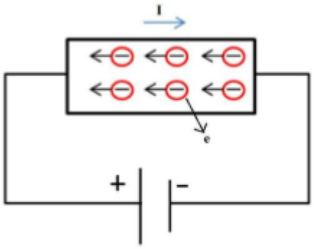


Figure 2: electric current representation

The charge of the electron has negative value while the charge of the proton is positive value and both equal in magnitude to 1.6 × 10−19 C Depending on knowing the charge of the electron in coulombs, we can determine how many electrons in one coulomb. Each coulomb has 6.24 × 1018 electrons. We can realize that the coulomb is a large unit of charge. The current i is equal by definition to the change rate of the charge measured in amperes (A)

$$i \triangleq dq\ dt \qquad (1)$$

The previous equation defines the mathematic relation between the charge q and the current i relating to the time. Also, we can find the charge q starting from the equation (1)

$$q \triangleq \int i\ \ dt\ t\ t0 \qquad (2)$$

If the current does not change with time called a direct current (dc). The symbol I represents such a current. On the other hand, if the current change with time called time-varying current. A common form of time-varying current is alternating current (ac) that varies sinusoidally with time.

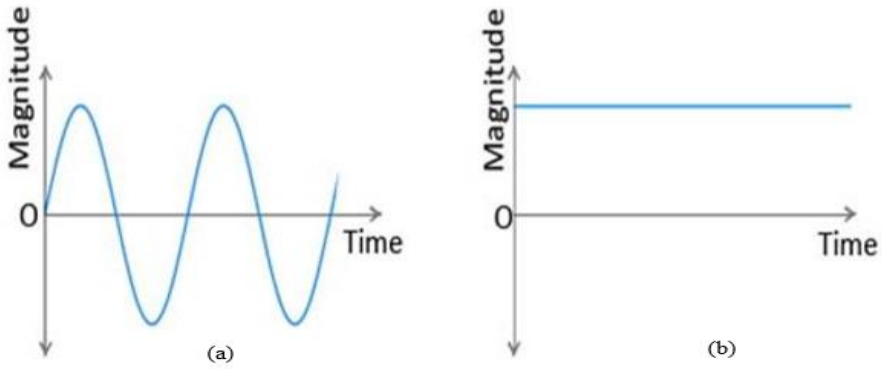


Figure 3: (a) alternation current, (b) Direct Current

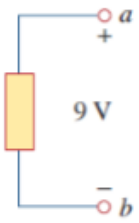
2. Voltage

Voltage, also called electromotive force, is a quantitative expression of the potential difference in charge between two points in an electrical field. In other words, the voltage is the energy required to move a unit charge through an element. The greater the voltage, the greater the flow of electrical current. Voltage can be direct or alternating. A direct voltage or (dc) voltage maintains the same polarity at all times and represents by V. In an alternating voltage, the polarity reverses direction periodically, hence the voltage represented by v. The voltage vab between two points a and b in an electric circuit is the energy needed to move a charge from a to b measured in volts; mathematically,

$$vab \triangleq dw\ dq \qquad (3)$$

The parameters in equation (3) w and q is the energy in Joule (J) and the charge in coulombs (C) respectively.

Voltage often is denoted vab to emphasize the fact the voltage difference between points a and b. If vab has a positive value, it means that point a is at a potential higher than that of point b. If vab = 9 V, we often use the terminology: "The voltage rise from b to a be 9 V," or "The voltage drop from a to b be 9 V."

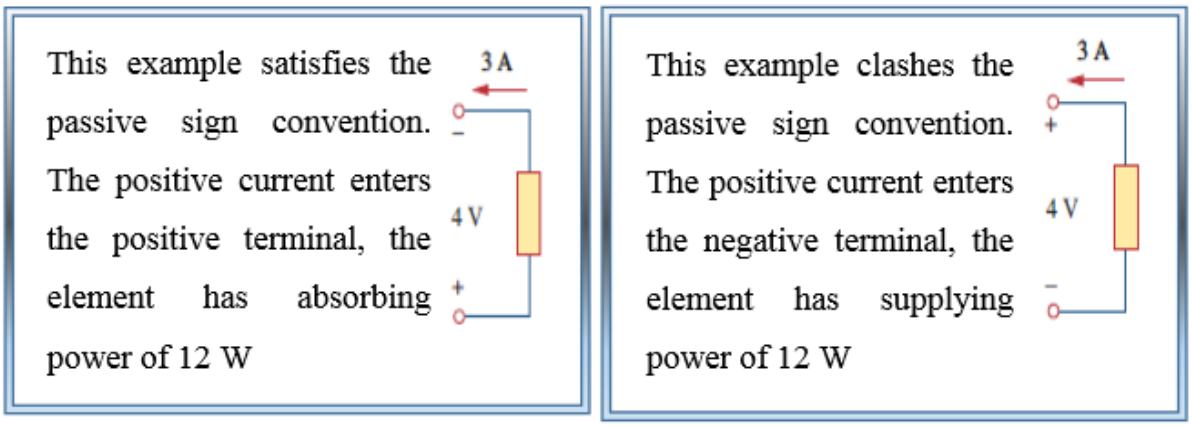


In an electric circuit, the Power is the time rate of expending or absorbing energy, measured in watts (W)

$$P = \frac{dw}{dt} = \frac{dw}{dq} \cdot \frac{dq}{dt} = v.i \qquad (4)$$

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 (4) 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 the $P = -vi$ the element is supplying power.



In any electric circuit, the total power supplied to the circuit must balance the total power absorbed. This is known as the law of conservation of energy.

$$\sum P = 0 \qquad (5)$$

The energy absorbed or supplied by an element from time t0 to t can be concluded using the equation (4) as follow

$$w = \int P\ dt\ t\ t0 = \int v\ i\ t\ t0\ dt \qquad (6)$$

The energy w represented in equation (6) measured in joules (J). Here you should be aware that the electric power utility uses the watt-hours (Wh) to measure the energy. Each watt-hour (Wh) equal to 3600 joules (J).

3. Circuit Elements

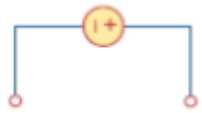
There are two types of element in electric circuits; passive element and active element. An active element, such as generator and battery, is capable of generating energy while a passive element, as resistor, capacitor and indicator, is not capable.

The most used active elements are voltage and current sources. Here the source could be independent or dependent source. Independent source provides a specified voltage or current independently of other circuit element. In contrast, dependence source has a source quantity

controlled by another voltage or current. It should be noted that an ideal dependent or independent voltage source will produce a current required to ensure the voltage as stated, whereas an ideal current will produce the necessary voltage to ensure the stated current flow. Thus, an ideal source could in theory supply an infinite amount of energy.

Dependent source are usually designated by diamond-shaped symbols. There are 4 possible types of dependent sources; Voltage-controlled Voltage source (VCVS), Current-controlled Voltage source (CCVS), Voltage-controlled Current source (VCCS), Current-controlled Current source (CCCS). We should know that a voltage sources comes with polarity (+ -) in its symbols, while a current source comes with an arrow.

Table 1: Active element Representation

	*This symbol refers to Independent voltage source used for constant or time-varying voltage.*
	*This symbol refers to Independent voltage source used for only constant voltage.*
	*This symbol refers to the Independent current source. The arrow indicates the direction of current.*
	*This symbol refers to the dependent current source. The arrow indicates the direction of current. This symbol could represents (VCCS) or (CCCS).*
	*This symbol refers to the dependent voltage source and could represents (VCVS) or (CCVS).*

Laboratory Electrical Equipment

In this section, we will examine the electrical equipment needed to complete this experiments. Basically, all the experiments that we will carry out in this course need DC variable Power supply, Breadboard, Resistors, Multimeters and conjunction wires. In what follow, we will study each of them separately.

1- Dc Variable Power supply

This Equipment considered as one of the main parts for carrying out all the electrical experiments that work in DC environment. Basically, the main function of this device is to convert electric power from a source to the correct voltage, current or the frequency to conduct the experiments. In Basic Circuit Laboratory, we use project board pp272 shown below.

Figure 4: project board pp272

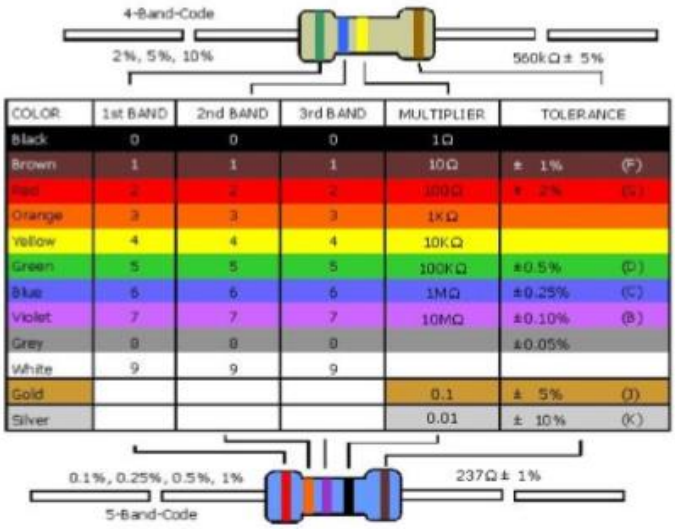
The sturdy housing of the project board pp272 provides a mains on-off switch with power on indicator, variable power supply controls 0V to +15V and 0V to -15V variable at up to 500mA, and access to the built-in power supply rails.

2- Breadboard

A breadboard is a construction base for prototyping of electronics. In the 1970s the solderless breadboard became available and nowadays the term "breadboard" is commonly used to refer to these. Because the solderless breadboard does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design [4]. The project board pp272 gives access to 2420 connection points, making it ideal for project work, laboratory use, and for schools and colleges.

3- Resistors

Resistors are passive element made for the express purpose of creating a precise quantity of resistance for insertion into a circuit. They are typically constructed of metal wire or carbon, and engineered to maintain a stable resistance value over a wide range of environmental conditions [5]. Resistor values are often indicated with color codes. The color code is given by several bands. Together they specify the resistance value, the tolerance and sometimes the reliability or failure rate. The number of bands varies from three till six. As a minimum, two bands indicate the resistance value and one band serves as multiplier [6]. The following figure describe the resistance color band technique.



COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE	
Black	0	0	0	1Ω		
Brown	1	1	1	10Ω	± 1%	(F)
Red	2	2	2	100Ω	± 2%	(G)
Orange	3	3	3	1KΩ		
Yellow	4	4	4	10KΩ		
Green	5	5	5	100KΩ	±0.5%	(D)
Blue	6	6	6	1MΩ	±0.25%	(C)
Violet	7	7	7	10MΩ	±0.10%	(B)
Grey	8	8	8		±0.05%	
White	9	9	9			
Gold				0.1	± 5%	(J)
Silver				0.01	± 10%	(K)

Figure 5: color band resistor table

4- Multimeters

Multimeters in definition is an electronic measuring that combines several measurement functions in one device. A typical Multimeters can measure voltage, current, and resistance.

Figure 6: A group of Multimeters Used in the laboratory

Practical Section

1- Construct the circuit in Fig 7

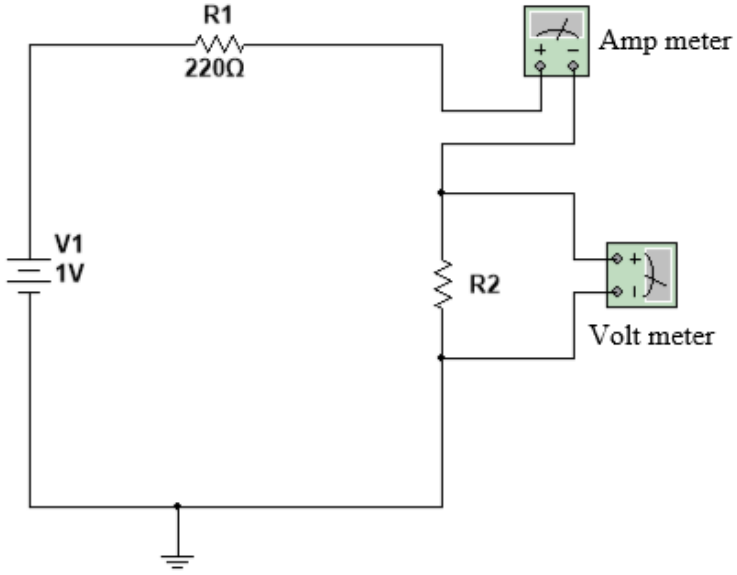


Figure 7: The circuit to be constructed

2- Increase the applied voltage in 2V steps from 0 up to 10 V and at each step measure the current passing and the voltage across the Resistor R2=2.2K ohms as shown on the Multimeter and fill in the Table2. Then repeat for R2=220ohms.

Table 2

Applied Volts	The Voltage across R2=2.2k	The current passing R2=2.2k	The Voltage across R2=220	The current passing R2=220
0 V				
2 V				
4 V				
6 V				
8 V				
10 V				

3- Plot a graph of V against I as shown in Fig. 8(a) and 8(b) for R=2.2K ohms and R=220 ohms respectively.

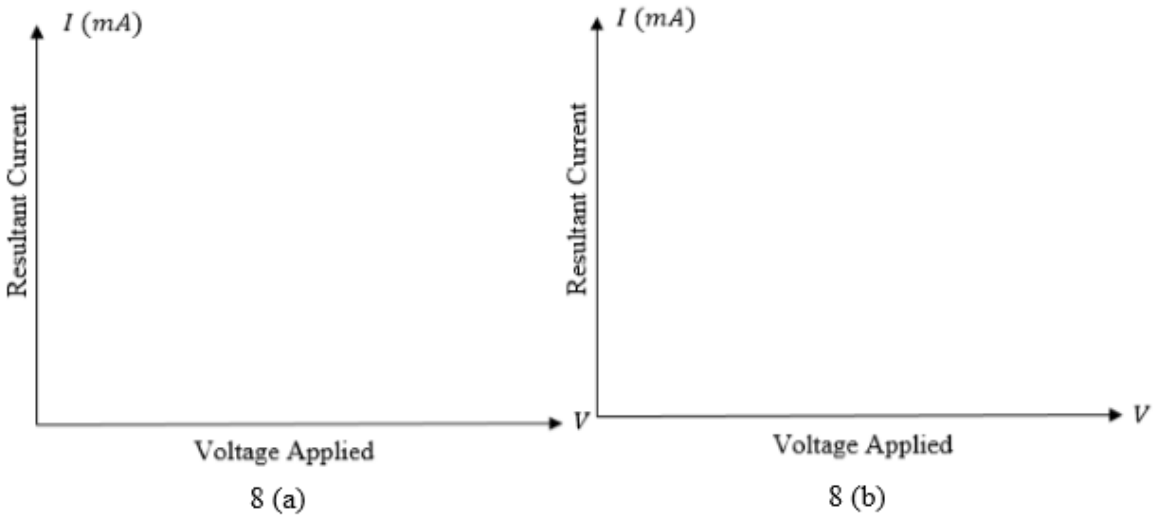


Figure 8: Plotting of V against I

References

[1] Alexander, C. K., & no Sadiku, M. (2000). Electric circuits. Transformation, 135, 4-5.

[2] What is Electricity? (2013). In Sparkfun. Retrieved from https://learn.sparkfun.com/tutorials/what-is-electricity/getting-started

[3] Basic Electronics (2010). In Clear Rice. Retrieved from https://www.clear.rice.edu/elec201/Book/basic_elec.html.

[4] Breadboard (2016). In Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Breadboard.

[5] Resistor (2014). In allaboutcircuits. Retrieved from https://www.allaboutcircuits.com/textbook/direct-current/chpt-2/resistors/.

[6] Resistor color code (2012). In resistorguid. Retrieved from http://www.resistorguide.com/resistor-color-code/

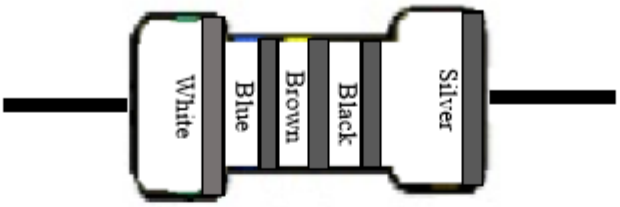
[7] Multimeters (2018). In Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Multimeter

Homework

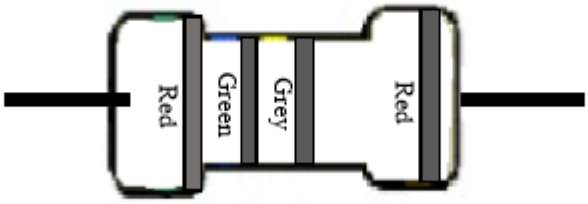
Problem 1) Find the charge $q(t)$ following through a device if the current is

$$i(t) = 10e^{-30t}sin40t\ A \qquad q\ (0) = 0$$

Problem 2) Given the Resistor Color Code in the figure 5, Calculate the minimum and maximum Resistance of the 5-band and 4-band resistors given in the Following figures.



Maximum	___ Ohms
Minimum	___ Ohms



Maximum	___ Ohms
Minimum	___ Ohms

Important Notes

1- This Lab session prepared mainly based on the first chapter of the course textbook in order to give students an introduction to the electric circuit Lab.

2- The students are expected to print at least the practical section before attending the lab session.

3- Each student is responsible for submission the practical part and Homework solutions individually by **(19/10/2018)**. After this date the Homework will not be accepted.

4- The homework and the practical part solution will be graded and evaluated precisely.

5- In case of Cheating, the grade will be zero and there is no possible way to change it.