



AL- MUSTAQBAL UNIVERSITY COLLEGE
DEPARTMENT OF BIOMEDICAL ENGINEERING

Laboratory Instrumentation

BME 422

Lecture 1

- Introduction -

Dr. Zaidoon AL-Shammari

Lecturer / Researcher

zaidoon.waleed@mustaqbal-college.edu.iq

Objectives



1. Engineering Training.
2. Read Electrical, Mechanical and Electronic Diagrams.
3. Understand the Block and schematic diagrams.
4. Open covers touch and feel the instruments.
5. Understand components and troubleshooting.



Each system that we will discuss we will try to do the followings:

1. Discuss the clinical and physiological considerations.
2. Discuss the expected block diagram.
3. Discuss the schematics diagram.
4. Discuss sample of the circuits.
5. Flow of signal.
6. Troubleshooting's.

Charge and Current



The current is flow of electrons. Thus current can be measured by measuring how many electrons are passing through material per second. This can be expressed in terms of the charge carried by those electrons in the material per second.

Key Point: *Electric current is the time rate of change of charge, measured in amperes (A).*

Mathematically we can write the relation between the charge (Q) and the electric current (I) as,

$$i = \frac{dq}{dt}$$

Charge and Current



Where current is measured in amperes (A), and

$$1 \text{ ampere} = 1 \text{ coulomb/second}$$

$$q = \int_{t_0}^t i dt$$

$$I = \frac{Q}{t} \text{ Ampere}$$

Where I: is the average current flowing;
Q: is the required for transfer of charge.

Concept of Electric Potential and Potential Difference

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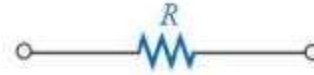


The electric potential at point due to a charge is one volt if one joule of work is done in moving a unit positive charge.

Key Point: *potential is the energy required to move a unit charge through an element, measured in volts (V).*

Key Point: *the difference between the electric potential at any two given points in a circuit is known as potential difference (p.d.) and measured in volts (V).*

Resistance



Key Point: *This property of an electric current circuit tending to prevent the flow of current and at the same time causes electrical energy to be converted to heat is called resistance.*

The resistance is denoted by the symbol 'R' and is measured in ohm symbolically represented as Ω . We can define unit ohm as below.

Key Point: *1 Ohm: Is the resistance of a circuit, when a current of 1 Ampere generates the heat at the rate of one joules per second.*

Factors Affecting the Resistance (R)



1. Length of the material: It varies directly as its length, l .
2. Cross-section area: It varies inversely as the cross-section area of the conductor, A .
3. The type and nature of the material.
4. Temperature: The temperature of the material affects the value of the resistance.

So for a certain material at a certain temperature we can write a mathematical expression as,

Factors Affecting the Resistance (R)



$$R = \frac{\rho l}{A}$$

Where

l: is the length in meters;

A: is the cross-sectional area in square meters;

ρ : is the resistivity in $\Omega \cdot m$;

and R: is the resistance in ohms.

Conductance (G)



The conductance of any material is reciprocal of its resistance and is denoted as G. It is the indication of ease with which current can flow through the material. It is measured in Siemens (S).

$$G = \frac{1}{R}$$

Key Point: *A material having highest value of conductivity is the best conductor while with poorest value of conductivity is the best insulator.*

Fundamental Quantities and Units



The common system of units are called 'SI' system i.e. International System of Units. The SI system is divided into six base units. The five fundamental or base units are length, mass, time, electric current, temperature, as Table below.

All other units are derived which are obtained from the above classes of units. The derived units are classified into three main groups.

1. Mechanical units,
2. Electrical units,
3. Heat units.

Quantity	unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K

Multiples and sub-multiples (Prefixes)



One great advantage of the SI unit is that it uses prefixes based on the power of 10 to relate larger and smaller units to the basic unit. Table below shows the SI prefixes and their symbols. For example, the following are expressions of the same distance in meters (m):
 $600,000,000 \text{ mm} = 600,000 \text{ m} = 600 \text{ km}$.

Multiplier	Prefix	Symbol
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^2	hecto	h
10	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

Example



EXAMPLE

- a. $1,000,000 \text{ ohms} = 1 \times 10^6 \text{ ohms}$
 $= 1 \text{ megaohm (M)}$
- b. $100,000 \text{ meters} = 100 \times 10^3 \text{ meters}$
 $= 100 \text{ kilometers (km)}$
- c. $0.0001 \text{ second} = 0.1 \times 10^{-3} \text{ second}$
 $= 0.1 \text{ millisecond (ms)}$
- d. $0.000001 \text{ farad} = 1 \times 10^{-6} \text{ farad}$
 $= 1 \text{ microfarad (uF)}$

