Al-Rasheed University
College
Medical Instrumentation
Tech. Eng.

Measurements & Medical Transducers

2nd Stage
Lecturer: Dr. Suhail Najm Abdallah

Chapter One(Lec. 1)
Basic Concepts of Measurement

1.1 Introduction

- **Instrument:** A device or mechanism used to determine the present value of the quantity under measurement.

المقياس: جهاز أو آلية تستخدم لتحديد القيمة الحالية للكمية قيد القياس.

- **Measurement:** the process of comparing an unknown quantity with an accepted standard quantity.

القياس: عملية مقارنة كمية غير معروفة بكمية معيارية.

- The simplest measuring system consists of four function units as illustrated in the block diagram shown in Fig. (1.1);

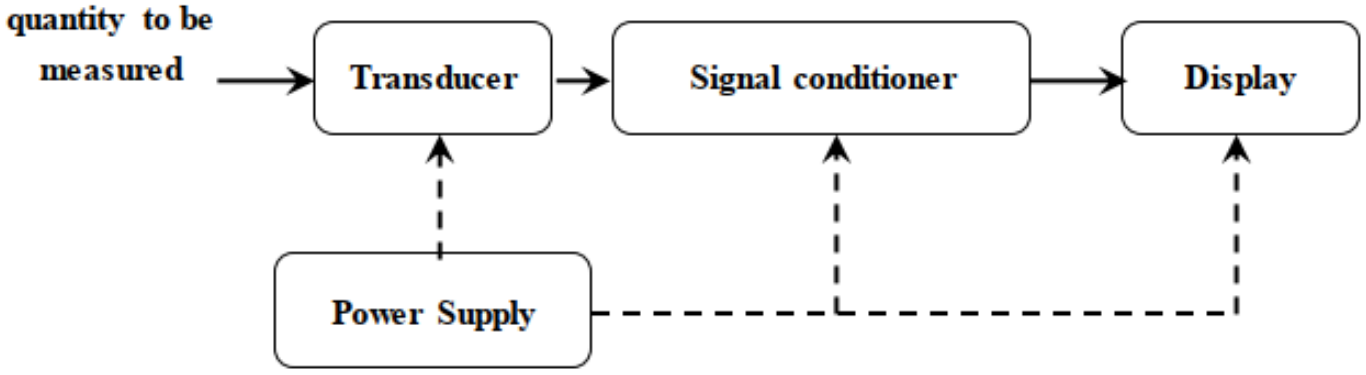

Fig (1.1). Block diagram of measurement system

- **The physical quantity** to be measured (measurand) may be electric quantity, force, pressure, level, strain, displacement, temperature, …etc.
- **Transducer** is defined as a device which converts the energy (quantity) from one form to another.
- **The signal conditioner** includes **all system elements** that are used to perform the necessary and distinct operations in the measurement sequence between the transducer unit and the output devices .
- **The display device** are used to display the required information about the measurements. The display device may be analogue panel meter, graphic recorder, magnetic tape recorder, cathode ray oscilloscope, or a digital display.
- **The power supply** provides the required excitation to the transducer and the necessary electrical power to the signal conditioner and the display device .

The board represents the signal conditioner

The battery represents the power supply

The display device (LED screen)

1.3 Methods of Measurements

Basically, there are two types of measurements:

1- Direct method

In the direct method of measurement, the quantity to be measured is compared directly against a standard of some kind of quantity.

Disadvantage:

(i) It is not always possible, feasible and practicable.

(ii) The involvement of human in this method makes it inaccurate and less sensitive.

2- Indirect Method

Indirect method of measurement is used only when the direct measurement is either impractical or impossible. It is less desirable and often less accurate than direct measurement.

❖ It is important to select the suitable method of measurement according to the following points:

(1) **Apparatus available.**

(2) **Accuracy desired** (specially for biomedical tests), where the diagnosis rely on the accuracy of the results.

(3) **Time required** (to handle more measurement at a time, useful in hospitals, where the load on the testing equipments is higher).

(4) **Difficulties in measurements** (availability of kits and other calibration tools), provided documentation on how to use (user manual), etc.

(5) **Conditions of measurements** (answering used for what? Specificity).

1.4 Types of Instruments

The history of development of instruments encompasses three phases:

1- Mechanical Instruments

Mechanical instruments are very reliable for static and stable conditions, but they are unable for respond rapidly to measurement of dynamic and transient conditions.

2- Electrical Instruments

Electrical methods of indicating **the output of transducers** are more rapid أسرع بكثير than the mechanical methods.

3- Electronic and digital Instruments

Electronic and digital instruments are becoming **more reliable** due to the improvements in the design and manufacturing processes of **semiconductor** devices.

1.5 Factors Effecting Instrument selection

1- Accuracy: represents the closeness with which an instrument reading approaches the true value of the variable being measured.

الدقة تمثل قرب القياسات الى القيمة الفعلية للمتغير المقاس.

2- Precision : a measure of the reproducibility of the measurements.

الإحكام يمثل إمكانية جهاز القياس إعطاء نفس القيمة (مطابقة) للمتغير المقاس لنفس الظروف والعوامل، في حال تم قياسه لأكثر من مرة.

3- Sensitivity: the ratio of output signal or response of the instrument to a change of input or measured variable.

الحساسية: هي نسبة أو سرعة تحسس جهاز القياس لتغير القيمة المقاسة أو للتغيرات التي تحيط بالقيمة المقاسة أو جهاز القياس.

4- Resolution represents the smallest change in measured value to which the instrument will respond.

دقة التفريق: يمثل أقل تغير بالقيمة المقاسة التي يستجيب لها جهاز القياس.

5- Error: represents the deviation from the true value of the measured variable.

تمثل الـ Error إنحراف قراءات أو قياسات جهاز القياس عن القيمة الفعلية للمتغيرالمقاس وذلك بفعل متغير أو مجموعة من المتغيرات التي توثر على عملية القياس.