



**Ministry of Higher Education and Scientific Research
Al-Mustaqbal University College
Department of Technical Computer Engineering**

**measurement and instrumentation
2stStage**

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2021-2022

Chapter One

Basic Concepts of Measurement

1.1 Introduction

Measurement generally involves using an instruments as a physical means for determining a quantity or variable.

The instrument serves as an extension of human facilities, where without the instrument aid, the human facilities become incapable of performing the measurement process.

The art of measurement is a wide discipline in both engineering and science encompassing the arts of detection, acquisition, control and analysis of data. It involves the measurement and recording and displaying of physical, chemical, mechanical or optical parameters. It is playing a vital role in all branches of scientific research and industrial process.

Recent advances in electronics, physics and material sciences and technologies have resulted in the development of many sophisticated and high precision measuring instruments.

The technology of using instruments to measure and control the physical and chemical properties of material is called the instrumentation. The use of instrumentation in systems like power plants, industries, processes and automatic productions has contributed significantly to the developing of economy and tremendous saving in time and labor involved.

1.2 Measuring system Configuration

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

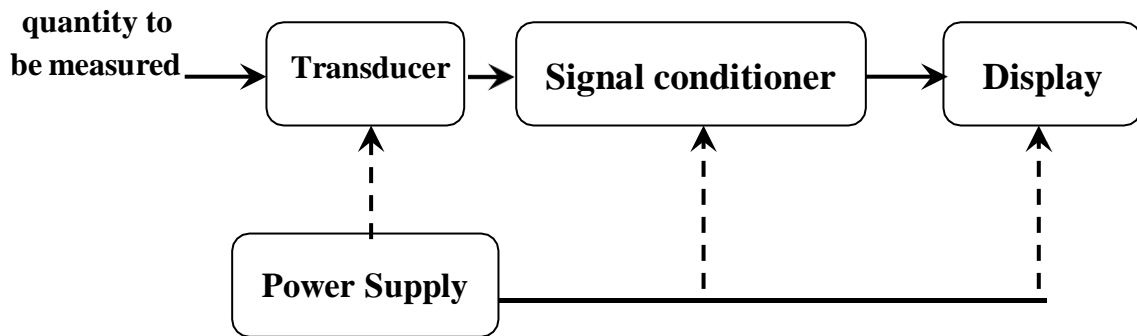


Fig (1.1). Block diagram of measurement system

The physical quantity to be measured (measure and) may be electric quantity, force, pressure, level, strain, displacement, temperature,... etc.

The input quantity for most instrumentation systems is a non-electrical quantity. In order to use electrical methods and techniques for measurement the nonelectrical by a device called a "transducer" therefore, the transducer is defined as a device which converts the energy 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 signal conditioning unit may perform linear processes like amplification, attenuation, integration, differentiation, addition, subtraction, ...etc, or may perform a nonlinear processes such modulation, demodulation, sampling, filtering, clipping, chopping, squaring, linearizing multiplication by another function, ...etc.

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.

1.3 Methods of Measurements

Basically, there are two types of measurements:

1- Direct method

In direct method of measurement, the quantity to be measured is compared directly against a standard of some kind of quantity. The magnitude of the quantity being measured is expressed in terms of a chosen unit for the standard and a numerical multiplier. In spite of the simplicity of the direct method of measurement, it suffer from the following 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:

- (i) Apparatus available.
- (ii) Accuracy desired.
- (iii) Time required.
- (iv) Difficulties in measurements.
- (v) Conditions of measurements.

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 to respond rapidly to measurement of dynamic and transient conditions. This is due to the fact that these instruments have moving parts which are rigid, heavy and bulky.

2- Electrical Instruments

Electrical methods of indicating the output of transducers are more rapid than the mechanical methods. But, the electrical systems normally depend upon a mechanical meter movement as indicating devices. This mechanical movement has some inertia and therefore these instruments have a limited time response.

3- Electronic and digital Instruments

Electronic and digital instruments are becoming more reliable on account of the improvements in the design and manufacturing processes of semiconductor devices. The advantages of the electronic and digital instruments over the electrical and mechanical instruments are:

- (i) Higher sensitivity.
- (ii) Faster response.
- (iii) Greater flexibility.
- (iv) Lower Weight.
- (v) Lower power consumption.
- (vi) Higher degree of reliability

- (vii) Have the ability of storing the measurement information to be used in future in the case of digital instruments.

1.5 Functions and applications of instruments and measuring systems

The instruments and measuring systems have the following functions:

1- Indicating and monitoring functions:

Instruments and systems use different kinds of methods for supplying information concerning the variable or quantity under measurement. This information is obtained as a deflection of a pointer of a measuring instrument. For example, the deflection of a pointer of a speedometer indicates the speed of the automobile at that moment or an ammeter or voltmeter indicates the value of current or voltage being measured at a particular instant.

2- Recording Functions:

In this case, the instrument makes a written record, usually on a paper, of the value of the quantity under measurement against some other variable such as time. For example, the recorder used for monitoring temperature to record the instantaneous values of temperature on a strip chart record.

3- Controlling Functions

This is one of the most important functions especially in the field of industrial control processes. In this case, the instrument or the system uses the information to control the original measured quantity. The Example of the controlling instrument is the thermostat for temperature control and the float for liquid level control.

4- Experimental Engineering Analysis:

Experimental engineering analysis is used for Solution of engineering problems, testing the validity of the theoretical prediction, formulation of empirical relationship, determination of systems promoters and performance indices, ...etc.