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

measurement and instrumentation

2st Stage

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Chapter Two

Performance Characteristic of instruments

2.1 Introduction

The instrument is a device for determining the value or magnitude of a quantity or variable. The performance of the measurement system is strongly governed by the characteristics of the instruments and the transducer used within them. Knowledge of these characteristics is essential when designing and using of these instruments to ensure that the measurement requirements are met.

The characteristics of any instruments or transducer are normally given in thedata sheet for the instrument supplied by the manufacturer. Instrument characteristics can be divided into two categories: static and dynamic characteristics.

2.2 Static Characteristics

Static characteristics are those that describe the instrument's parameters in steady-state when the Instrument output has settled to a steady readings the static characteristics of the instrument have a fundamental effect on the quantity of measurements obtained from it.

The various static characteristics are defined as follows.

1. **Accuracy**: is the degree of correctness of measurement it is the closeness with which the measured value approach the true value

The measurement accuracy is given as:

$$A= \frac{Xm}{Xt} * 100\% \qquad ....(2.1)$$

Where

A = the accuracy

X_m = the measured value

Xt = the true value

Example (2.1)

An ohmmeter us used to measure a resistance of 10 Determine the accuracy of this instrument if its reading is 9.9 Ω.

Solution

$$\mathbf{A= \frac{Xm}{Xt} * 100\%}$$

$$A = \left[\frac{9.9}{10} \right] * 100\ \%$$

= 99%

2. **Inaccuracy**: is the maximum error which may exist in measurement, and it is sometimes known as uncertainly.

Example: (2.2)

For the instrument of Example (2.1), determine the inaccuracy.

Solution

$$\text{The inaccuracy} = \left[1 - \frac{xm}{xt}\right] * 100\ \%$$

$$= \left[1 - \frac{9.9}{10}\right] * 100\ \%$$

$$= 1\ \%$$

3. **Precision**: Is the closeness of the measured value to each other. It is a numerical value refers to the closeness of the measured values to the mean value.

The precision is given as:

$$P_i = 1 - \frac{Xi - \bar{X}}{\bar{X}} * 100\% \quad \text{..........(2.2)}$$

Where

P = the precision

Xi = the measured value.

$\bar{X}$ = the mean value of the measured values

Example (2.3)

A voltmeter is used to measure a voltage of 9 V. the following measurements are made: 8.9, 8.8 , 9.1 , 9.2 , 8.9 calculate the precision of the third reading.

Solution

$$\bar{X} = \frac{8.9 + 8.8 + 9.1 + 9.2 + 8.9}{5}$$

$$\bar{X} = \frac{44.9}{5} = 8.98$$

$$P_i = 1 - \frac{Xi - \bar{X}}{\bar{X}} * 100\%$$

$$p_i = 1 - \frac{9.1 - 8.98}{8.98} *100\% = 0.9866$$

The degree of repeatability or reproducibility in measurements from an instrument is an alternative way of expressing its precision.

4. **Repeatability**: Is the closeness of the output readings of an instrument when the same input is applied repetitively over a short period of time, with the same instrument .

5. **Reproducibility:** Is the closeness of the output readings of an instrument for the same input when there are changes in the measuring instrument .

6. **Sensitivity**: Is the ratio of the change in the instrument output to the change in the measured quantity.

The sensitivity of the indicating instrument is given as:

$$S = \frac{\text{RATIO CHANGE IN OUTPUT READINGS}}{\text{RATIO CHANGE IN INPUT READINGS}} \quad .... \quad (2.4)$$

The sensitivity of measurement is therefore the slope of the straight line drown to represent the relationship between the measured quantity and output reading, as shown in Fig. (2.1)

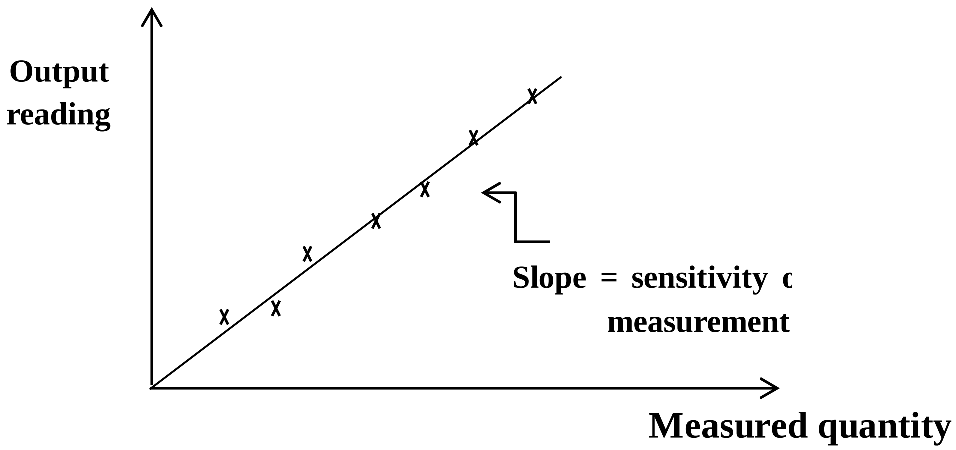


Fig (2.1). The sensitivity of measurement representation

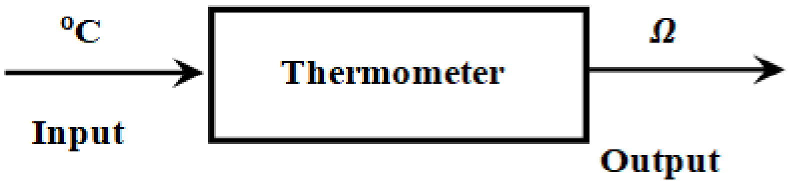
<u>Example: (2.4)</u>

The following resistance values of a platinum-resistance thermometer were measured at a range of temperature determine the measurement sensitivity of instrument.

Resistance (Ω)	Temperature (C°)
307	200
314	230
321	260
328	290
335	320

Solution:

Here, the instrument is a thermometer, therefore; the input to this instrument is a temperature, while the output is the ohms, as shown below:



$$S = \frac{\Delta out}{\Delta in}$$

$$S = \frac{314-307}{230-200}$$

$$S = \frac{7}{30} = 0.233$$

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