STATIC ERRORS IN INSTRUMENTS

The static error is defined earlier as the difference between the true value of the variable and the value indicated by the instrument. The static error may arise due to number of reasons. The sta tic errors are classified as:

1) Gross errors

2) Systematic errors

3) Random errors

Gross errors:

The gross errors mainly occur due to carelessness or lack of experience of a human being. These cover human mistakes in readings, recordings and calculating results. These errors also occur due to incorrect adjustments of instruments. These errors cannot be treated mathematically. These errors are also called personal errors. Some gross errors are easily detected while others are very difficult to detect.\

Systematic errors:

The systematic errors are mainly resulting due to the shortcomings of the instrument and the characteristics of the material used in the instrument, such as defective or worn parts, ageing effects, environmental effects, etc.

A constant uniform deviation of the operation of an instrument is known as a systematic error.

There are three types of systematic errors as

1) Instrumental errors 2) Environmental errors 3) Observational errors

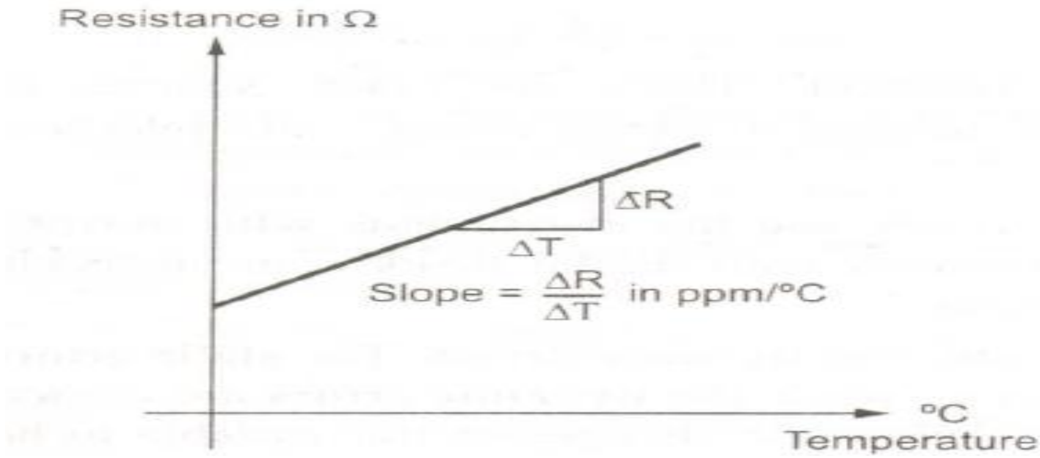
Random errors:

Some errors still result, though the systematic and instrumental errors are reduced or atleast accounted for. The causes of such errors are unknown and hence, the errors are called **random** errors. These errors cannot be determined in the ordinary process of taking the measurements.

Absolute and relative errors:

When the error is specified interms of an absolute quantity and not as a percentage, then it is called an absolute error.

Thus the voltage of 10 ± 0.5 V indicated ± 0.5 V as an absolute error. When the error is expressed as a percentage or as a fraction of the total quantity to be measured, then it is called relative error.



Generally the relative error in case of resistances is specified as percentage
tolerances. Another method of expressing error is by specifying it as parts per million (ppm), relative to the total quantity. So it is a relative error specification . Generally change in resistance with temperature is indicated in ppm. °C shows the variation in resistance with Temperature temperature. Thus if a resistance of 100 kD. Has a temperature coefficient of 50 *ppm/"C* means
50 parts per millionth per degree celcius. Thus one millionth of 100 kohm. is 0.1 ohm and 50 such parts means 5 D. Th1-1s 1"<:::change in temperature causes change of 5 D in 100 kohm. resistor.

Limiting errors:

The manufacturers specify the accuracy of the instruments within a certain percentage of full scale reading. The components like the resistor, inductor, capacitor are guaranteed to be within a certain percentage of rated value. This percentage indicates the deviations from the nominal or specified value of the particular quantity. These deviations from the specified value are called **Limiting Errors.** These are also called **Guarantee Errors.**

Thus the actual value with the limiting error can be expressed mathematically as,

$$\boxed{A_a = A_s \pm \delta A}$$

where A_a = Actual value

A_s = Specified or rated value

δA = Limiting error or tolerance

Relative limiting error:

This is also called fractional error. It is the ratio of the error to the specified magnitude of a quantity.

Thus $$e = \frac{\delta A}{A_s}$$

where e = Relative timing error

From the above equation, we can write,

$$\delta A = e \cdot A_s$$

and

$$A_a = A_s \pm \delta A$$

$$= A_s \pm e\, A_s$$

$$\therefore \quad A_a = A_s [1 \pm e]$$

The percentage relative limiting error is expressed as

$$\%\, e = e \times 100$$

The relative limiting error can be also be expressed as,

$$e = \frac{\text{Actual value } (A_a) - \text{Specified value } (A_s)}{\text{Specified value } (A_s)}$$