STATIC & DYNAMIC CHARACTERISTICS

The performance characteristics of an instrument are mainly divided into two categories:

1) Static characteristics

2) Dynamic characteristics

Static characteristics:

The set of criteria defined for the instruments, which are used to measure the quantities which are slowly varying with time or mostly constant, i.e., do not vary with time, is called 'static characteristics'.

The various static characteristics are:

i)   Accuracy

ii)   Precision

iii)   Sensitivity

iv)   Linearity

v)   Reproducibility

vi)   Repeatability

vii)   Resolution

viii) Threshold

ix)   Drift

x)   Stability

xi)   Tolerance

xii)   Range or span

Accuracy:

It is the degree of closeness with which the reading approaches the true value of the quantity to be measured. The accuracy can be expressed in following ways:

a) Point accuracy:

Such accuracy is specified at only one particular point of scale. It does not give any information about the accuracy at any other point on the scale.

b) Accuracy as percentage of scale span:

When an instrument as uniform scale, its accuracy may be expressed in terms of scale range.

c) Accuracy as percentage of true value:

The best way to conceive the idea of accuracy is to specify it in terms of the true value of the quantity being measured.

Precision:

It is the measure of reproducibility i.e., given a fixed value of a quantity, precision is a measure of the degree of agreement within a group of measurements. The precision is composed of two characteristics:

a) Conformity:

Consider a resistor having true value as 2385692, which is being measured by an ohmmeter. But the reader can read consistently, a value as 2.4 Due to the nonavailability of proper scale. The error created due to the limitation of the scale reading is a precision error.

b) Number of significant figures:

The precision of the measurement is obtained from the number of significant figures, in which the reading is expressed. The significant figures convey the actual information about the magnitude & the measurement precision of the quantity.

The precision can be mathematically expressed as:

$$P = 1 - \left| \frac{X_n - \overline{X_n}}{\overline{X_n}} \right|$$

Where, P = precision

X_n = Value of nth measurement

$\overline{X_n}$ = Average value the set of measurement values

Sensitivity:

The sensitivity denotes the smallest change in the measured variable to which the instrument responds. It is defined as the ratio of the changes in the output of an instrument to a change in the value of the quantity to be measured.

Mathematically it is expressed as,

$$\text{Sensitivity} = \frac{\text{Infinitesimal change in output}}{\text{Infinitesimal change in input}}$$

$$=qo/qi$$

Thus, if the calibration curve is liner, as shown, the sensitivity of the instrument is the slope of the calibration curve. If the calibration curve is not linear as shown, then the sensitivity varies with the input.
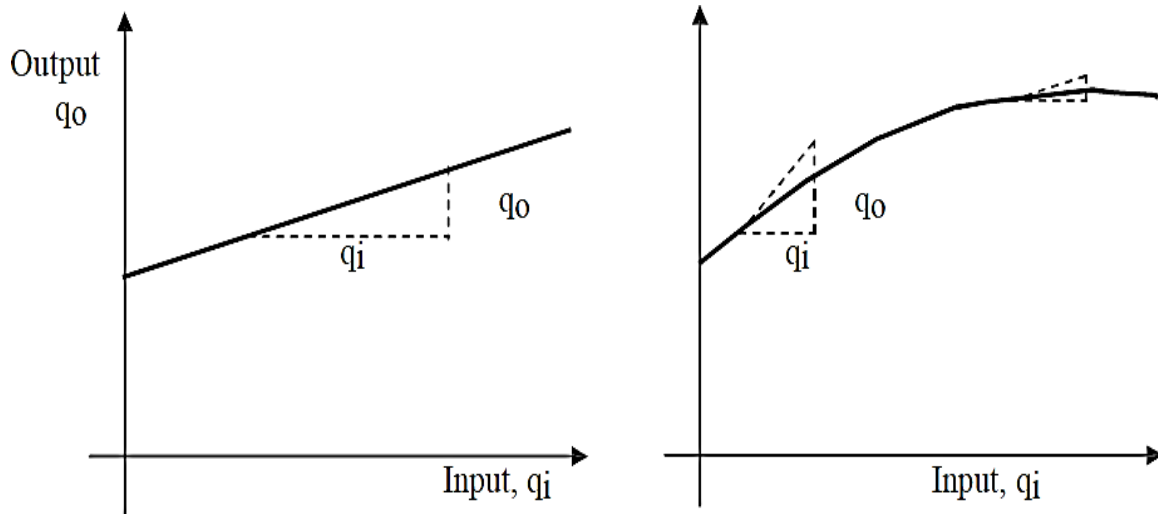

Fig 1.2 Sensitivity Curve

Inverse sensitivity or deflection factor is defined as the reciprocal of sensitivity.

Inverse sensitivity or deflection factor = 1/ sensitivity =qi/qo

Linearity

The linearity is defined as the ability to reproduce the input characteristics symmetrically & linearly.

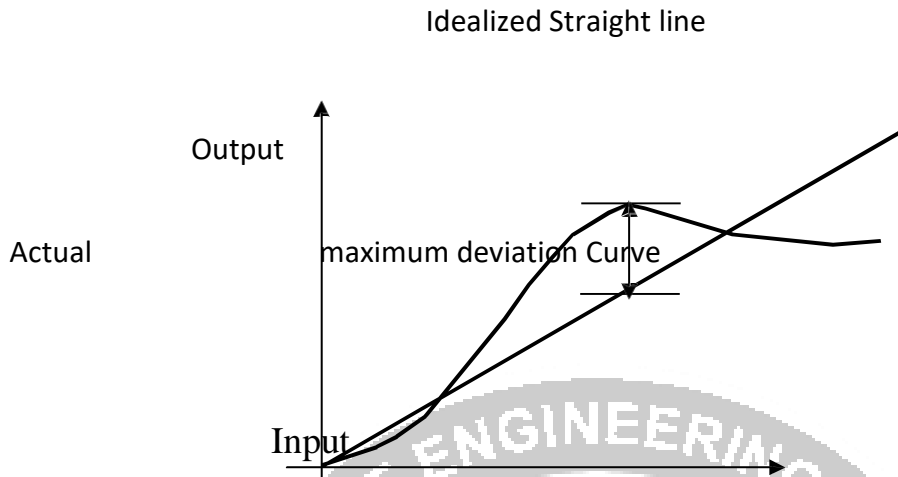The curve shows the actual calibration curve & idealized straight line.

Idealized Straight line

Output

Actual   maximum deviation Curve

Input

Fig 1.3 Actual calibration curve & idealized straight line Max.

% non-linearity =   Deviation   of   output from   idealized

Straight line Full scale reading

Reproducibility:

It is the degree of closeness with which a given value may be repeatedly measured. It is specified in terms of scale readings over a given period of time.

Repeatability:

Output

Span drift

Nominal

Characteristics

Input

Output

zero drift

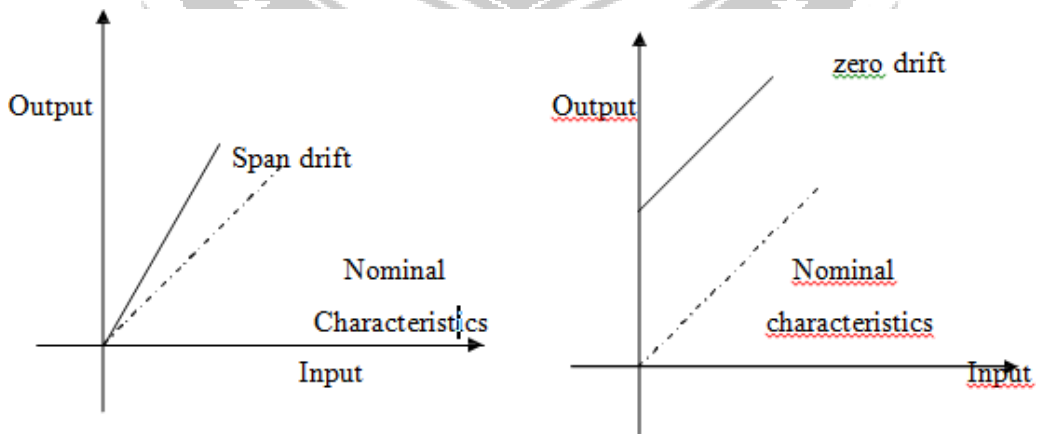Nominal

characteristics

Input

Fig 1.5 Drift Curve

Drift:

Drift may be classified into three categories:

a) Zero drift:

If the whole calibration gradually shifts due to slippage, permanent set, or due to undue warming up of electronic tube circuits, zero drift sets in.

b) Span drift or sensitivity drift

If there is proportional change in the indication all along the upward scale, the drifts is called span drift or sensitivity drift.

c) Zonal drift:

In case the drift occurs only a portion of span of an instrument, it is called zonal drift.

Resolution:

If the input is slowly increased from some arbitrary input value, it will again be found that output does not change at all until a certain increment is exceeded.

This increment is called resolution.

Threshold:

If the instrument input is increased very gradually from zero there will be some minimum value below which no output change can be detected. This minimum value defines the threshold of the instrument.

Stability:

It is the ability of an instrument to retain its performance throughout is specified operating life.

Tolerance:

The maximum allowable error in the measurement is specified in terms of some value which is called tolerance.

Range or span:

The minimum & maximum value of a quantity for which an instrument is designed to measure is called its range or span.