



ELECTRONIC MEASUREMENT & INSTRUMENTATION

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What is measurement?

measurement of a given quantity is an act of comparison between the quantity to be measured and a standard.

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Standard should be commonly accept.

What is an Instrument?

The device used for comparison to perform measurement.

Absolute and Secondary Instrument

* Absolute Instrument \Rightarrow These instrument do not provide direct reading the value shown by this instrument is used in a certain formulae to get the exact value of the measurement of the quantity. * High in accuracy.

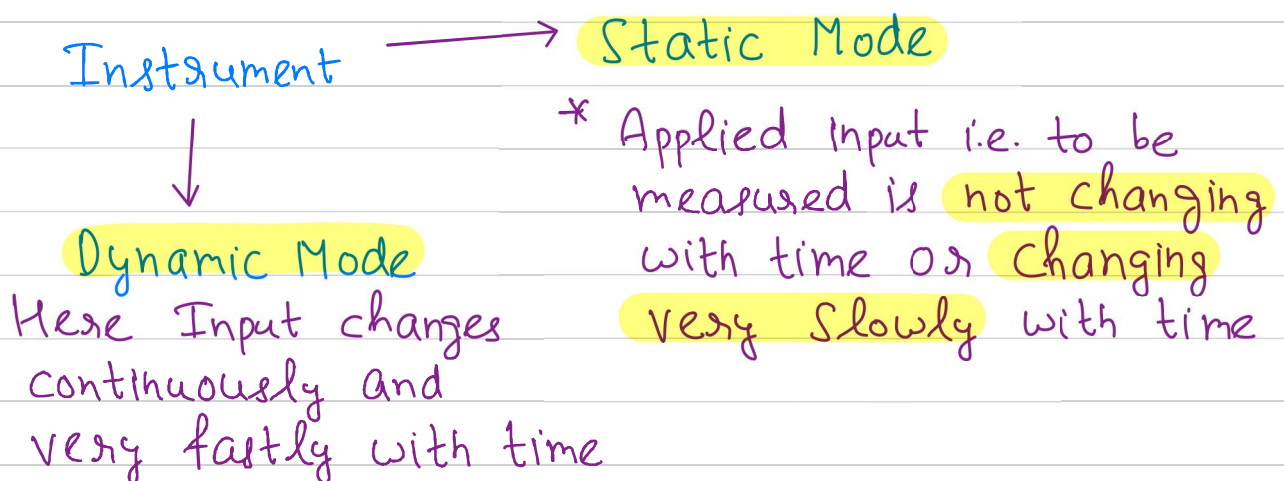
* Secondary Instrument \Rightarrow The deflection on the scale give us the value of measurement of the quantity directly. * They have less accuracy.

What is Calibration \Rightarrow It is a process of comparing the instrument result with the result of \rightarrow (1) Primary standard
(2) Secondary standard of high acc.
(3) Any instrument with known acc.
Calibration improve the accuracy of device.

The absolute instruments are used for calibrating the secondary instrument

Secondary ins. are used in day to day life and Absolute ins. are used in Labs

Characteristic of the instrument of the measurement system.



\rightarrow Static characteristic of an instrument \Rightarrow Signifies the quality of measurement done by instrument in static mode.

→ Dynamic characteristics of an instrument signifies the quality of measurement done by the device in dynamic mode.

Static characteristics of a device ⇒

(1) Accuracy ⇒ Accuracy of the instrument is the closeness of instrument reading to the true value of the quantity.

True value of a quantity ⇒

(1) Comparison with standard.

(2) It is equal to avg of infinite reading of measurement performed by a non-standard instrument.

Static Error ⇒ $\text{Error} = \text{Measured value} - \text{True value}$

Relative Error ⇒
$$\frac{\text{Measured value} - \text{True value}}{\text{True value}}$$

% error =
$$\left(\frac{\text{Measured value} - \text{True value}}{\text{True value}} \right) \times 100$$

(2) Scale Range and Span \Rightarrow

ex: If any thermometer scale has
min value = -20°C and Max value = 120°C

Scale Range $\Rightarrow -20^{\circ}\text{C}$ to 120°C

Scale Span $\Rightarrow 140^{\circ}\text{C}$

* Scale Range \Rightarrow If the highest and lowest point of reading of an instrument is X_{max} and X_{min} , Scale range will be X_{min} to X_{max}

* Scale span will be $X_{\text{max}} - X_{\text{min}}$

Measured value is $250^{\circ}\text{C} \pm 2\%$ in thermometer reading from $200-400^{\circ}\text{C}$

* Here Measured value is 250°C but true value will be $250^{\circ}\text{C} \pm 2\%$ of span

So true value will be within

$$250 \pm \frac{2}{100} \times \text{span}$$

$$= 250 \pm \frac{2}{100} \times 200$$

$$= 250 \pm 4$$

$$= 254 - 246^{\circ}\text{C}$$

(3) Reproducibility and Repeatability \Rightarrow

Repeatability \Rightarrow

The closeness of the reading measured by the instrument for same input keeping the condition exactly same while each experiment

Reproducibility \Rightarrow This defines the closeness of the reading by the instrument for same input even after changing the observer, temp etc.

Drift \Rightarrow The gradual shift/change in reading of the instrument over extended period of time during which applied input do not change.

Drift = 0 for high repeatability & Reproducibility

(4) Precision \Rightarrow Measure of Closeness of group of reading is called Precision.

High Repeatability & high Reproducibility means high Precision.

* High Precision do. not means high accuracy.

* Precision is necessary & Sufficient condition for accuracy. \Rightarrow False.