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INTRODUCTION TO ELECTRICAL MEASURING INSTRUMENTS

Basic Concepts of Measurement

Measurement of a quantity is important not only in our daily life and also in all branches of engineering

"The measurement of a given quantity is the act or result of a quantitative comparison between an unknown and a predefined standard quantity".

In order to obtain meaningful results of measurement there are two requirements

- Standard use for comparison purposes must be accurately defined and should be commonly.
- The apparatus used and procedure developed must be provable.

The standard of comparison must be of the same character as the measured, and usually is prescribed and defined by a legal or recognized agency or organization. Few Examples of Standard Organization:

- ISO: The International Organization for Standardization.
- IS: Indian Standards.
- ANSI: The American National Standards Institute.
- NIST: The National Institute of Standards and Technology.

Application of Measurement System

Applications of measurement in engineering classified into only three major categories:

1. Monitoring of processes and operations.
2. Control of processes and operations.
3. Experimental engineering analysis.

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Measuring Instruments

An instrument is a device in which we can determine the magnitude or value of the quantity to be measured. The measuring quantity can be voltage, current, power and energy etc.

Basic classification of measuring instruments

1. Mechanical instruments
2. Electrical instruments
3. Electronic instruments

Other classification of instruments

1. Absolute instruments or Primary Instruments
2. Secondary instruments

1. Absolute instruments or Primary Instruments

These instruments gives the magnitude of quantity under measurement in terms of physical constants of the instrument. These instruments do not require comparison with any other standard instrument. E.g. Tangent galvanometer, Raleigh current balance, Absolute electrometer.

2. Secondary Instruments

These instruments are so constructed that the quantity being measured can only be determined by the output indicated by the instrument. These instruments are calibrated by comparison with an absolute instrument or another secondary instrument, which has already been calibrated against an absolute instrument. Therefore secondary instruments are most commonly used.

Classification of Secondary Instruments

(a) Classification based on the various effects of electric current (or voltage) upon which their operation depend. They are

- **Magnetic eff**ect: Used in ammeters, voltmeters, watt-meters, integrating meters etc
- **Heating effect**: Used in ammeters and voltmeters.
- **Chemical effect**: Used in dc ampere hour meters.
- **Electrostatic effect**: Used in voltmeters.
- **Electromagnetic induction effect**: Used in ac ammeters, voltmeters, watt meters and integrating meters.

(b) **Classification based on the Nature of their Operations**

- Indicating instruments
- Recording instruments
- Integrating instruments

(c) **Classification based on the Kind of Current that can be Measured**

- Direct current (dc) instruments
- Alternating current (ac) instruments
- Both direct current and alternating current instruments (dc/ac instruments)

(d) **Classification based on the method used**.

- Direct measuring instruments
- Comparison instruments

(e) **Analog and Digital Instruments**

Classification of errors

Error may arise from different sources are usually classified as under

1. Gross errors
2. Systematic errors
3. Random errors

1. Gross error

This class of errors mainly covers human mistake in reading instruments and recording and calculating measuring results.

2. Systematic error

These types of error divided into three categories:

- Instrumental error
- environmental errors
- observational errors

3. Random errors

It has been consistently found that experimental results show variation from one reading to another, even after all systematic errors have been accounted . These errors are due to multitude of small factors which change or fluctuate from one measurement to another.