ROHINI

COLLEGE OF ENGINEERING AND TECHNOLOGY

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DEPARTMENT OF MECHANICAL ENGINEERING

24ME403 - METROLOGY & MEASUREMENTS

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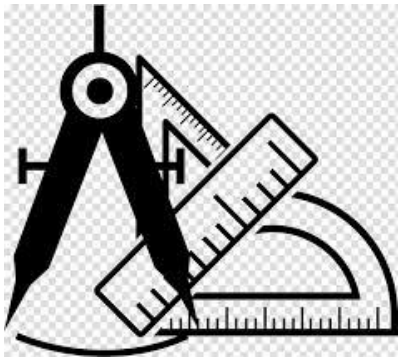
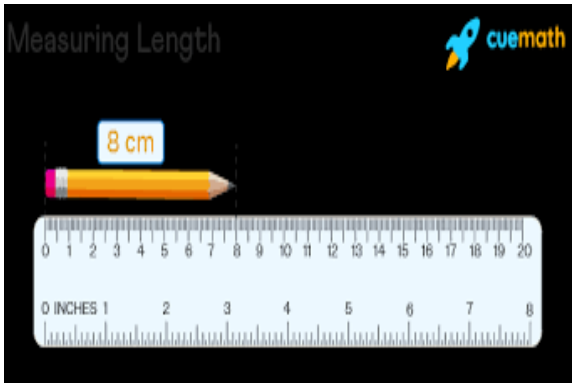


UNIT I: BASICS OF METROLOGY

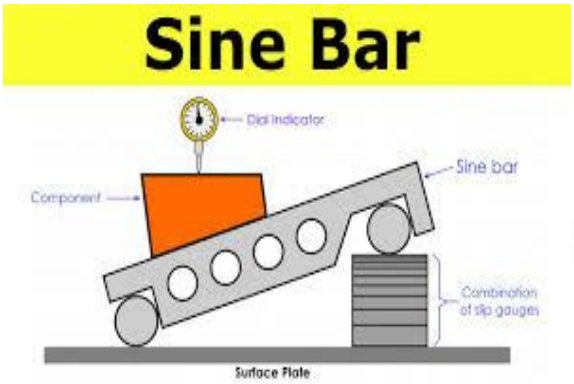
CO1: To explain the basics of standards of measurement and errors in industrial applications.

Methods of Measurement

1) **Direct method (or) primary measurement**
   - In this method, the quantity to be measured is directly measured with an instrument, without needing to calculate it from other measurements.
   - **Example**: Scale, protractor, thermometer, etc.,



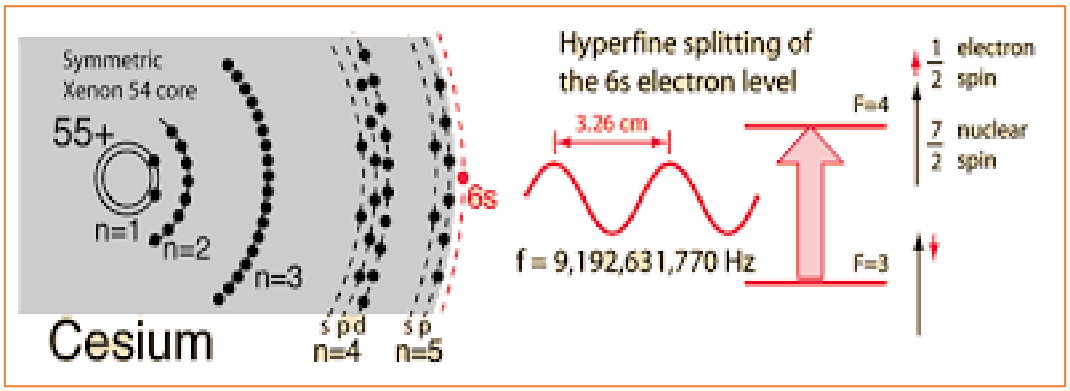
2) **Indirect method**
   - In this method, the quantity to be measured is determined indirectly by measuring other related parameters and using a known mathematical relationship to calculate it.
   - **Example**: Angle measurement using sine bar, measurement of discharge of fluid using Venturimeter, etc.,



3) **Absolute method (or) Fundamental method**

- This is a highly accurate technique where a physical quantity is determined directly from its base definition, using fundamental physical laws and constants, without relying on calibrations against another standard.
- **Example**: using a cesium atomic clock for time measurement, using iodine stabilized He-Ne laser for length measurement, etc.,

  The typical emission wavelength of He-Ne laser is about 632.8 nm in air.



4) **Comparison method**

- In this method, the quantity to be measured is determined by directly comparing it with a known standard or reference of the same kind.
- **Example**: Weight measurement using a traditional weighing scale.

5) **Transposition method**

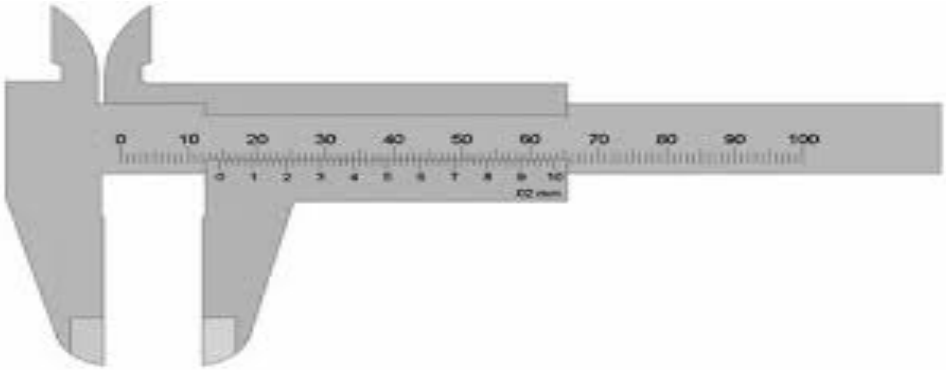
- This is a comparison technique where the quantity being measured and a known standard are interchanged in position within the measurement system to eliminate errors and determine the unknown value accurately.
- **Example**: Weighing a Gold coin using an unequal-arm balance.

6) **Substitution method**

- This is a technique where the unknown quantity is replaced by a known adjustable standard in the same measurement setup until the instrument gives the same reading.
- **Example**: Weighing a jewel with a single-pan balance.

7) **Coincidence method**

- In this method, the quantity to be measured is determined by achieving precise alignment or coincidence between a movable marker and a reference scale or pattern, allowing very fine resolution without complex calculations.
- **Example**: Vernier caliper, Vernier height gauge, etc.,

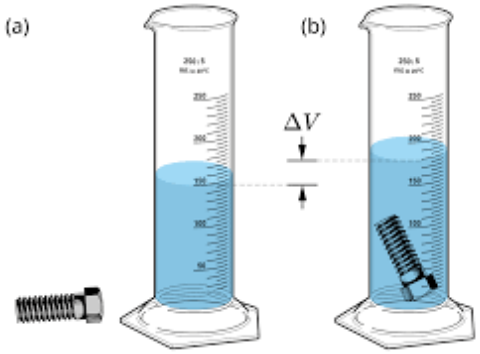


8) **Deflection method**

- In this method, the quantity to be measured is directly indicated by the deflection or displacement of a pointer on a calibrated scale, without needing to calculate it from other measurements.
- **Example**: Speedometer, analogue pressure gauge, etc.,

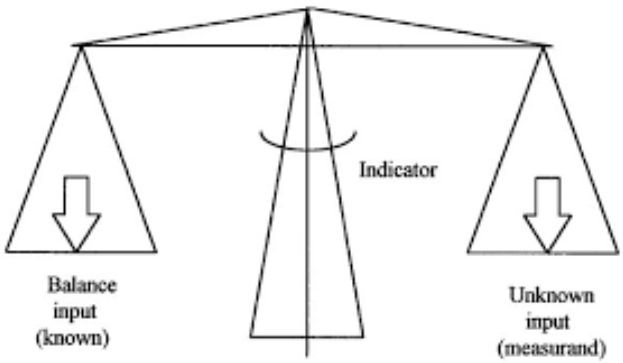
9) **Complementary method**

- In this method, the quantity to be measured is determined by completing a full known total, where the measured complementary part is subtracted from the whole to find the unknown value, rather than measuring it directly with an instrument.
- **Example**: Determining the volume of a solid object by means of the displaced volume of liquid.



10) **Method of Null measurement**

- In this method, the quantity to be measured is balanced against a known standard until a detector shows zero effect (null condition).
- **Example**: Using a Wheatstone bridge to find an unknown resistor – by adjusting a known resistor until the galvanometer shows zero current.


Indicator
Balance
input
(known)
Unknown
input
(measurand)