

Unit:- 03

Standards...

Date:- 10/12/24

Day:- Tuesday

► Standards:-

A standard of measurement is a physical representation of a unit of measurement.

Classification of Standard:-

Standards of measurement classified by their function and application in the following categories.

- 1.) International Standards
- 2.) Primary Standards
- 3.) Secondary Standards
- 4.) Working Standards.

1.) Primary Standards:-

A primary standard refers to a high accuracy device or instrument used as a reference to calibrate other measurement devices. It ensures the accuracy and reliability of measurement in electronics.

Key Characteristics of Primary Standard:-

- 1) High Precision:- Offers extremely accurate measurements.
- 2) Traceability:- Linked to International measurement standards (e.g., SI units).
- 3) Stability:- Maintains consistent performance over time without frequent recalibration.
- 4) Minimal Uncertainty:- Has a very low margin of error.

2) Secondary Standards:-

Secondary standards are reference instruments or devices calibrated against primary standards. They are used for routine testing and calibration in laboratories or industries where high precision isn't as critical as with primary standards.

Key Characteristics of Secondary Standards:-

- Secondary standards are less accurate than primary standards.
- They are more practical for everyday use due to availability and lower cost.
- Regularly calibrated against primary standards to maintain accuracy.

→ Exam

- A standard against which secondary standards are calibrated.
- It is used for calibration of secondary standards.

3) Work

Work used for calibration of secondary standards.

Key

- Used for calibration of secondary standards.
- Less accurate than primary standards.
- Easier to maintain.
- Require regular calibration against primary standards.

* Exam

→ A standard against which secondary standards are calibrated.

→ It is used for calibration of secondary standards.

→ Example :-

- A standard digital multimeter calibrated against a primary standard voltmeter is a secondary standard.
- It is used in industries to measure voltage, current and resistance for routine maintenance.

3) Working Standards :-

Working Standards are instruments or devices used in day-to-day testing, measurements and calibrations. These are calibrated against secondary standards to ensure their accuracy and reliability.

Key Characteristics of Working Standards :-

- Used frequently in practical and routine applications.
- Less precise than secondary or primary standards.
- Easier to handle, cost-effective and durable.
- Requires periodic calibration to maintain accuracy.

* Example :-

→ A handheld digital multimeter used by electricians to measure voltage, current and resistance in fieldwork or routine maintenance.

→ It is calibrated against secondary standards for accuracy.

4) IEEE Standards:-

→ IEEE standards are globally recognized technical guidelines and protocols established by the Institute of Electrical and Electronics Engineers (IEEE).

→ These standards ensure compatibility, safety, reliability and quality in various industries, particularly in electronics, electrical engineering and computer science.

Key Characteristics of IEEE standards:-

1) Global Applicability:-

IEEE standards are accepted and implemented worldwide.

2) Interoperability:-

They ensure that system and devices from different manufacturers can work together seamlessly.

3) Regular Updates:-

Standards are updated regularly to incorporate technological advancements.

* Example:-

IEEE 754:- Standard for floating-point arithmetic, used in most computing system.

► Bridges...

Basic Bridge Network



What is an bridge circuit?

Bridge is a special electric circuit consisting of 4 arms and 4 nodes arranged in a predefined manner.

Bridges

DC Bridges

AC Bridges

→ DC supply

→ Contains Resistance only (R)

→ Phasor's not involved

{ Resultant no. 1 & Resultant current are in same phase }

→ AC supply

→ Contains, R, L, C

(Resistance, Inductance, Capacitance).

→ Phasor's are involved.

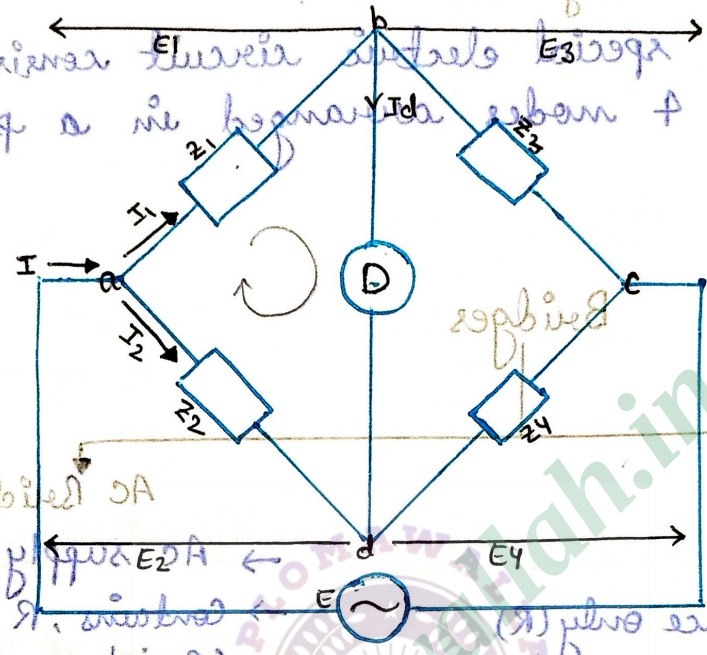
Uses of AC Bridges:-

→ For calculating R, L, C, power factors (PF), dissipation factor (df) and loss tangent (LT) without using voltmeter and Ammeter AC Bridges are used.

→ It is also used for providing phase shifting and providing feedback path to oscillation.

Basic Bridge Network :-

What is a bridge circuit? A bridge is a special electrical circuit consisting of four impedances arranged in a quadrilateral form. It is used to measure the value of an unknown impedance by comparing it with known impedances.



AC bridges → contain R, L, C, Inductance, Capacitance, Resistance, Inductance.
 DC bridges → contain Resistance only (R).
 In a balanced bridge, $I_d = 0$, $V_{bd} = 0$.
 Resultant voltage is zero. (Resultant is in same phase & resultant is 0 & resultant is 0.)
 $E_1 = E_2$ (Voltage across branches)

$$I_1 \times Z_1 = I_2 \times Z_2$$

4 (Nodes) a, b, c, d

4 (Branches) ab, bc, cd, da
 D = Detector
 S = Source.
 Source and detector are connected in opposite nodes.

$I_d = 0$ & $V_{bd} = 0$ is a necessary condition for balance. If source and detector are connected in same nodes then bridge will never come into balance condition.

$$E_1 = E_2$$

$$I_1 Z_1 = I_2 Z_2$$

$$I_1 = \frac{E}{Z_1 + Z_3} = I_3$$

$$\& I_2 = \frac{E}{Z_2 + Z_4} =$$

$$|5| > |5| \times |0| > |5| = |0| > |5| \times |0| > |5|$$

$$|5| + |5| > |5| |5| = |0| + |0| > |5| |5|$$

$$|5| |5| = |5| |5|$$

$$|0| + |0| > |0| + |0|$$

$$I_1 Z_1 = I_2 Z_2$$

$$\frac{E}{Z_1 + Z_3} \times Z_1 = \frac{E}{Z_2 + Z_4} \times Z_2$$

avg of blue (b) two

$$\frac{Z_1}{Z_1 + Z_3} = \frac{Z_2}{Z_2 + Z_4}$$

$$Z_1 (Z_2 + Z_4) = Z_2 (Z_1 + Z_3)$$

$$Z_1 Z_2 + Z_1 Z_4 = Z_1 Z_2 + Z_2 Z_3$$

$$Z_1 Z_4 = Z_2 Z_3$$

(Bridge Balance equation).

$$Y_1 Y_4 = Y_2 Y_3 \neq \text{Balance condition}$$

Z is complex no. (Assume)

$$Z_1 = |Z_1| \angle \theta_1$$

$$Z_2 = |Z_2| \angle \theta_2$$

$$Z_3 = |Z_3| \angle \theta_3$$

$$Z_4 = |Z_4| \angle \theta_4$$

operates at a specific frequency, usually 50 or 60 Hz.

less sensitive to noise and interference.

high accuracy, typically 1.0 - 2.0 %

Frequency

Sensitivity

Accuracy



$$|z_1| < \theta_1 \times |z_4| < \theta_4 = |z_2| < \theta_2 \times |z_3| < \theta_3$$

$$|z_1||z_4| < \theta_1 + \theta_4 = |z_2||z_3| < \theta_2 + \theta_3$$

$$\boxed{|z_1||z_4| = |z_2||z_3|} \rightarrow \text{Negative Criteria}$$

$$\boxed{\angle \theta_1 + \angle \theta_4 = \angle \theta_2 + \angle \theta_3} \rightarrow \text{Phase Criteria}$$

→ General equation for bridge balance:-

1. detector current should be $I_d = 0$
2. Potential difference between point (b) and point (d) should be zero.

Day:- Wednesday

Date:- 18/12/24

Comparison of AC and DC Bridges:-

	AC BRIDGE	DC BRIDGE
Measurement	Measures Impedance, Inductance and capacitance.	Measures resistance, voltage and current.
Frequency	Operates at a specific frequency, usually 50 or 60 Hz.	operates at DC (zero frequency).
Sensitivity	Less sensitive to noise and interference.	More sensitive to noise and interference.
Accuracy	High accuracy, typically 0.1 - 0.5%.	Moderate accuracy typically 0.5 - 2%.

Application	Used in audio equipment & medical devices and power systems.	Used in laboratory instruments, process control and automotive systems.
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► Application of AC Bridges:-

- 1) Impedance Measurement :- AC bridges are used to measure impedance, inductance and capacitance in audio equipment, medical devices and power systems.
- 2) Audio Equipment :- AC bridges are used in audio equipment such as equalizers, filters and amplifiers.
- 3) Medical Devices :- AC bridges are used in medical devices such as ECG and EEG machines and ultrasound equipment.
- 4) Power Systems :- AC bridges are used in power systems to measure impedance, inductance and capacitance in transmission lines, transformers and generators.
- 5) Materials Testing :- AC bridges are used to measure the electrical properties of materials such as conductivity, permittivity and permeability.

► APPLICATION OF DC BRIDGE:-

- 1) Resistance Measurement :- DC bridges are used to measure resistance, voltage and current in laboratory instruments, process control, and automotive systems.
- 2) Laboratory Instruments :- DC bridges are used in laboratory instruments such as multimeter, oscilloscopes and signal generators.

3) Process Control :- DC bridges are used in process control application such as temperature control, pressure control, and flow control.

4) Automotive Systems :- DC bridges are used in process control automotive systems such as battery testing, starter motor testing and alternator testing.

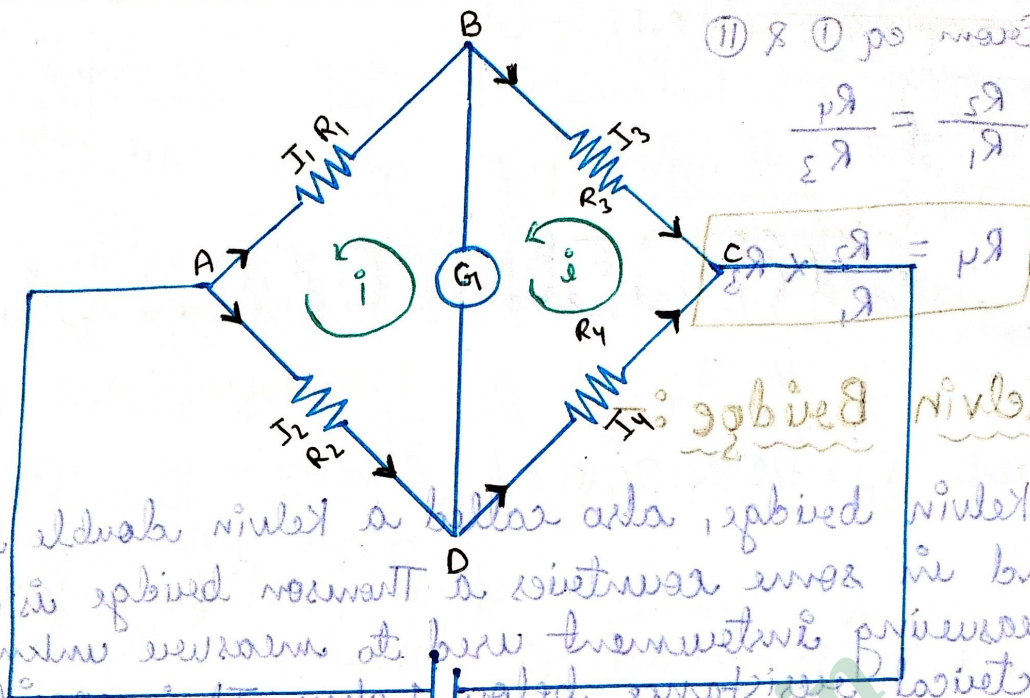
5) Aerospace and Defense :- DC bridges are used in aerospace and defense applications such as testing and calibration of electronic equipment.

► Wheatstone Bridge :-

- A wheatstone bridge is an electrical circuit used to measure unknown resistance by balancing two legs of a bridge circuit, one leg containing the unknown resistance.
- Used to measure usually an accuracy of around 0.1%.

» Components of a Wheatstone Bridge :-

- 1) Unknown Resistance (R_x) :- The resistance to be measured.
- 2) Known Resistance (R_1 & R_2) :- Two known resistance.
- 3) Variable Resistance (R_3) :- One variable resistance.
- 4) Voltage Source (V) :- A voltage source applied across the bridge.
- 5) Null Detector :- A device used to detect the null or balance point.



Kelvin Bridge

A Kelvin bridge, also called a Kelvin double bridge, is a special modification of a Wheatstone bridge used to measure unknown electrical resistance below 1 ohm. It is specifically designed to measure resistors that are connected in parallel with a known resistor.

Wheat Stone Bridge :- To measure an unknown resistance at balance condition. $V_B = V_D$, $I_g = 0$

• KVL in loop ADBA :-

$$\Rightarrow I_2 R_2 + 0 - I_1 R_1 = 0$$

$$\Rightarrow I_2 R_2 = I_1 R_1$$

$$\Rightarrow \boxed{\frac{I_1}{I_2} = \frac{R_2}{R_1}} \quad \text{--- (1)}$$

• KVL in loop DCBD :-

$$\Rightarrow I_4 R_4 - I_3 R_3 + 0 = 0$$

$$\Rightarrow I_4 R_4 = I_3 R_3$$

$$\Rightarrow I_2 R_4 = I_3 R_3 \quad \dots \dots \left\{ \begin{array}{l} I_1 = I_3 \\ I_2 = I_4 \end{array} \right\}$$

$$\Rightarrow \boxed{\frac{I_1}{I_2} = \frac{R_4}{R_3}} \quad \text{--- (2)}$$

From eq ① & ②

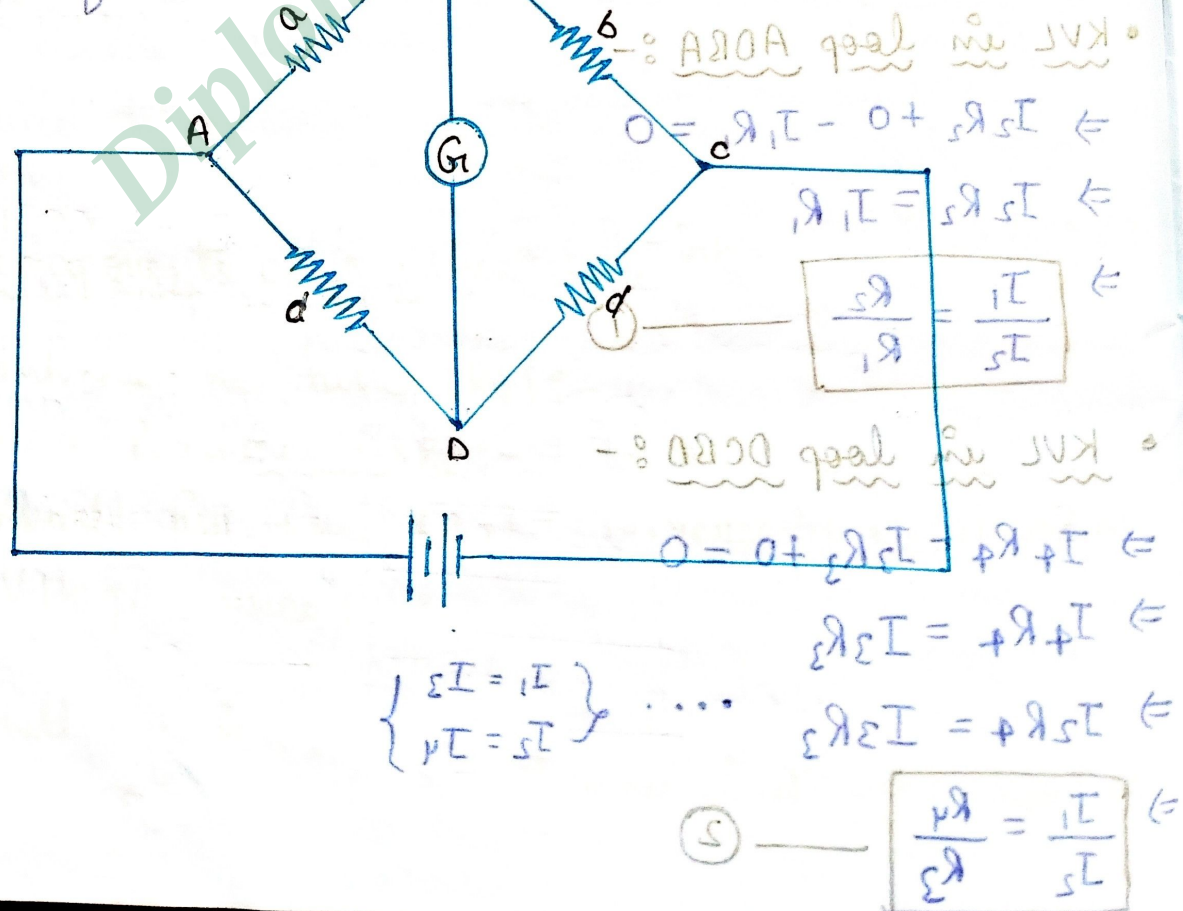
$$\frac{R_2}{R_1} = \frac{R_4}{R_3}$$

$$R_4 = \frac{R_2 \times R_3}{R_1}$$

Kelvin Bridge :-

A Kelvin bridge, also called a Kelvin double bridge and in some countries a Thomson bridge is a measuring instrument used to measure unknown electrical resistance below 1 ohm. It is specifically designed to measure resistors that are constructed as four terminal resistor.

Wheatstone bridge :- To measure unknown resistance at balance condition $0 = \rho I$, $\Delta V = 0V$.



>> Application of Wheatstone Bridge :-

The wheatstone bridge is mainly used to :-

- 1> Measure Unknown resistance :- It helps find the value of a resistor that we don't know.
- 2> Temperature sensing :- It detects temperature changes by measuring how a resistor's value changes with temperature.
- 3> Strain measurement :- It measures changes in resistance caused by stretching or compressing an object, useful in testing materials.
- 4> Load Cells :- It helps measure weight or force by detecting tiny changes in resistance when a load is applied.
- 5> Sensors :- It's used in device like, pressure, humidity, and gas sensors to measure changes in resistance.
- 6> Calibration :- It's used to check and calibrate other measuring devices for accuracy.

Electrical / Non-electrical ← Sensor physical quantity

(Humidity/Temp) ← Temperature ← 2°