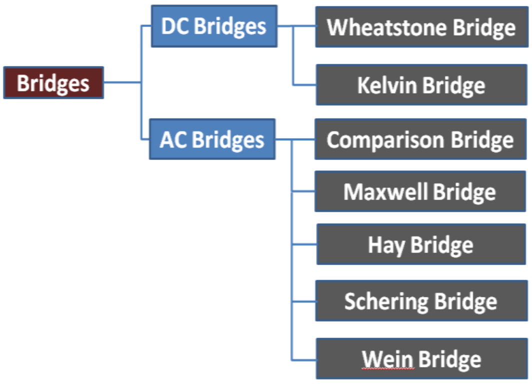
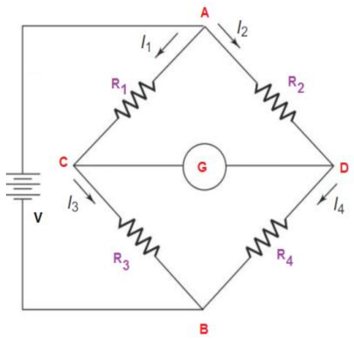
BRIDGES

- A bridge circuit consists of a network of four arms forming a closed circuit, with a source of current applied to two opposite junctions and a current detector connected to the other junctions.
- Each arm may contain one or two electrical components.
- Types of Bridges



DC Bridges

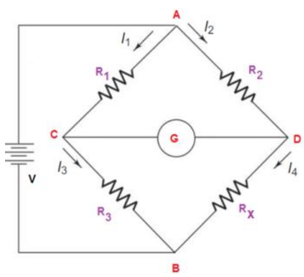
- Bridge circuit is operated (excited) with only DC voltage signal.
- DC bridges are used to measure the value of unknown resistance.
- Consist of **four arms** and each arm consists of a resistor.
- Among which, two resistors have fixed resistance values, one resistor is a variable resistor and the other one has an unknown resistance value.



WHEATSONE BRIDGE

Wheatstone's bridge is a simple DC bridge having four arms. These four arms form a rhombus and each arm consists of one resistor. To find the value of unknown resistance, we need the galvanometer and DC voltage source.

- Used for accurate measurement of resistance.
- Measurements from 1Ω to 1 MΩ with an accuracy ±0.25%



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

To obtain the bridge balance equation

$$I_1 R_1 = I_2 R_2 \qquad (1)$$

For the galvanometer current to be zero, the following conditions should be satisfied

$$I_1 = I_3 = \frac{V}{R_1 + R_3} \qquad (2)$$

$$I_2 = I_4 = \frac{V}{R_2 + R_x} \qquad (3)$$

Subs. in eq. (1)

$$\frac{V * R_1}{R_1 + R_3} = \frac{V * R_2}{R_2 + R_x}$$

$$R_1 * (R_2 + R_x) = R_2 * (R_1 + R_3)$$

$$R_1 R_2 + R_1 R_x = R_2 R_1 + R_2 R_3$$

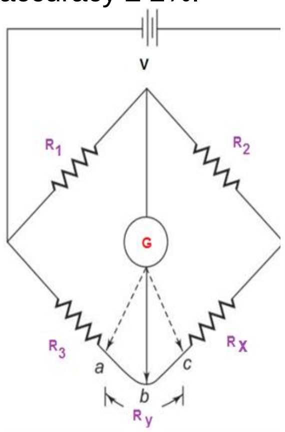
$$\mathbf{R_x} = \frac{\mathbf{R_2 R_3}}{\mathbf{R_1}} \qquad (4)$$

Equation for the bridge to be balanced

KELVIN'S BRIDGE

Kelvin's bridge is a modification of Wheatstone 's bridge is used

- Used to measure values of resistance below 1Ω.
- Measurements from 0.001Ω with an accuracy ± 2%.



$$\mathbf{R_x = \frac{R_2 R_3}{R_1}}$$

$$\frac{R_{cb}}{R_{ab}} = \frac{R_1}{R_2} \qquad (1)$$

and the usual balance equations for the bridge give the relationship

$$(R_x + R_{cb}) = \frac{R_1}{R_2}\,(R_3 + R_{ab}) \qquad (2)$$

but $\quad R_{ab} + R_{cb} = R_y$ and $\dfrac{R_{cb}}{R_{ab}} = \dfrac{R_1}{R_2}$

$$\frac{R_{cb}}{R_{ab}} + 1 = \frac{R_1}{R_2} + 1$$

$$\frac{R_{cb} + R_{ab}}{R_{ab}} = \frac{R_1 + R_2}{R_2}$$

i.e. $\quad \dfrac{R_y}{R_{ab}} = \dfrac{R_1 + R_2}{R_2}$

Therefore $\quad R_{ab} = \dfrac{R_2\, R_y}{R_1 + R_2}$ and as $R_{ab} + R_{cb} = R_y$

$\therefore \quad R_{cb} = R_y - R_{ab} = R_y - \dfrac{R_2\, R_y}{R_1 + R_2}$

$\therefore \quad R_{cb} = \dfrac{R_1 R_y + R_2 R_y - R_2 R_y}{R_1 + R_2} = \dfrac{R_1 R_y}{R_1 + R_2}$

Substituting for R_{ab} and R_{cb} in Eq. (2), we have

$$R_x + \frac{R_1 R_y}{R_1 + R_2} = \frac{R_1}{R_2}\left(R_3 + \frac{R_2 R_y}{R_1 + R_2}\right)$$

$$R_x + \frac{R_1 R_y}{R_1 + R_2} = \frac{R_1 R_3}{R_2} + \frac{R_1 R_2 R_y}{R_2 (R_1 + R_2)}$$

Hence $\quad R_x = \dfrac{R_1 R_3}{R_2} \qquad (3)$