SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution

Coimbatore-35

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

IIYEAR/ III SEMESTER

19ECT201 Electrical Engineering and Instrumentation

unit 5-MEASUREMENT SYSTEMS

BRIDGES-WHEATSTONE

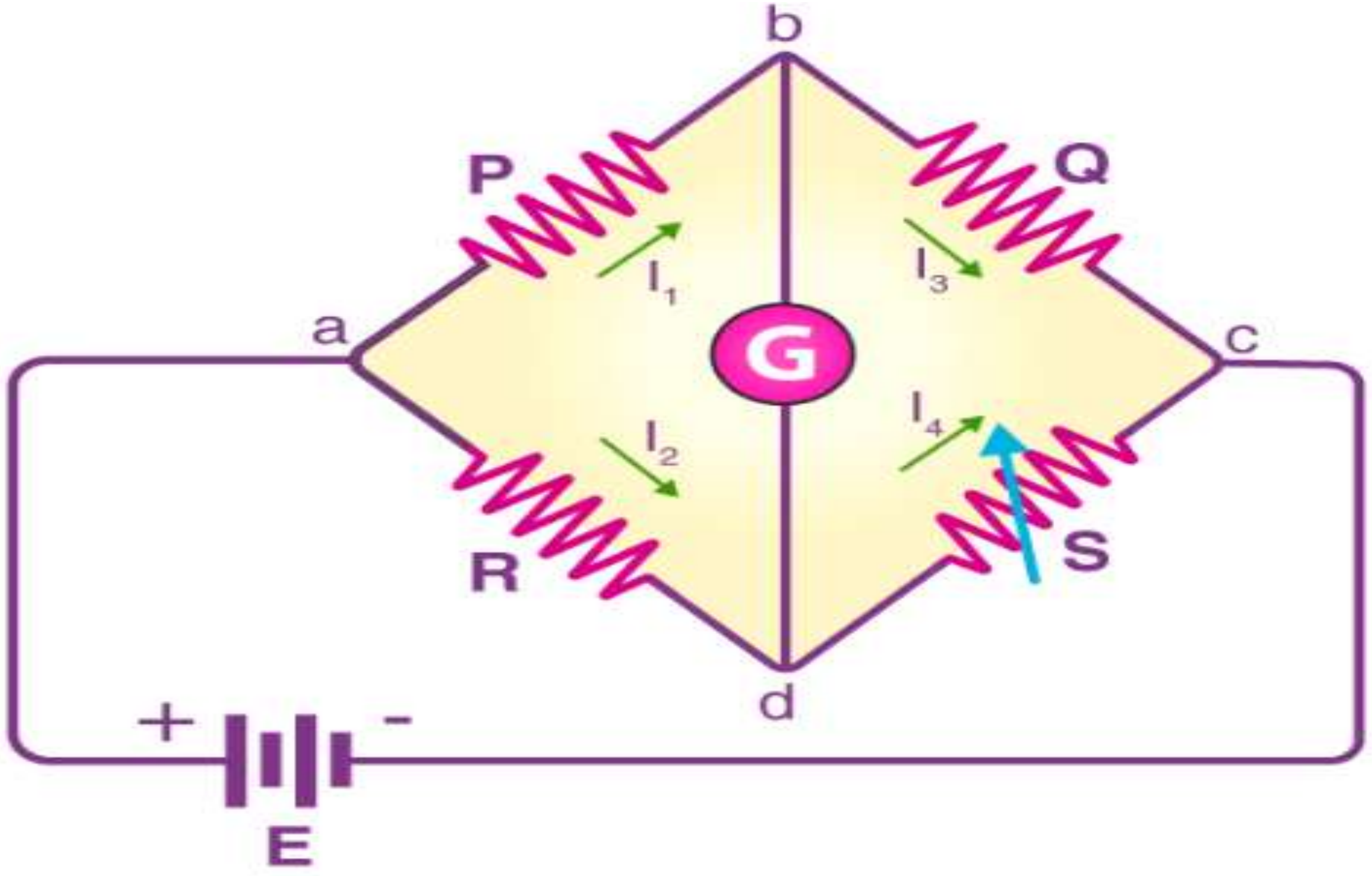
WHEAT STONE BRIDGE

Wheatstone bridge, also known as the resistance bridge, calculates the unknown resistance by balancing two legs of the bridge circuit. One leg includes the component of unknown resistance.

The Wheatstone Bridge Circuit comprises two known resistors, one unknown resistor and one variable resistor connected in the form of a bridge. This bridge is very reliable as it gives accurate measurements.

Construction

A Wheatstone bridge circuit consists of four arms, of which two arms consist of known resistances while the other two arms consist of an unknown resistance and a variable resistance. The circuit also consists of a galvanometer and an electromotive force source. The emf source is attached between points *a* and *b* while the galvanometer is connected between points *c* and *d*. The current that flows through the galvanometer depends on its potential difference.


b
P
Q
a
c
G
R
S
d
+
-
E

WORKING PRINCIPLE

The Wheatstone bridge works on the principle of null deflection, i.e. the ratio of their resistances is equal, and no current flows through the circuit. Under normal conditions, the bridge is in an unbalanced condition where current flows through the galvanometer. The bridge is said to be balanced when no current flows through the galvanometer. This condition can be achieved by adjusting the known resistance and variable resistance.

Wheatstone Bridge Derivation

The current enters the galvanometer and divides into two equal magnitude currents as I_1 and I_2. The following condition exists when the current through a galvanometer is zero,

$I_1P = I_2R..(1)$

The currents in the bridge, in a balanced condition, are expressed as follows:

$I_1 = I_3 = \frac{E}{P+Q}$

$I_2 = I_4 = \frac{E}{R+S}$

Here, E is the emf of the battery.

By substituting the value of I_1 and I_2 in equation (1), we get

$$\frac{PE}{P+Q} = \frac{RE}{R+S}$$
$$\frac{P}{P+Q} = \frac{R}{R+S}$$
$$P(R+S) = R(P+Q)$$
$$PR + PS = RP + RQ$$
$$PS = RQ \,..(2)$$
$$R = \frac{P}{Q} \times S \,..(3)$$

Equation (2) shows the balanced condition of the bridge, while (3) determines the value of the unknown resistance.

In the figure, R is the unknown resistance, S is the standard arm of the bridge and P and Q are the ratio arm of the bridge.

APPLICATIONS & LIMITATIONS

Wheatstone Bridge Application

The Wheatstone bridge is used for the precise measurement of low resistance.

Wheatstone bridge and an operational amplifier are used to measure physical parameters such as temperature, light, and strain.

Quantities such as impedance, inductance, and capacitance can be measured using variations on the Wheatstone bridge.

Wheatstone Bridge Limitations

For low resistance measurement, the resistance of the leads and contacts becomes significant and introduces an error.

For high resistance measurement, the measurement presented by the bridge is so large that the galvanometer is insensitive to imbalance.

The other drawback is the resistance change due to the current’s heating effect through the resistance. Excessive current may even cause a permanent change in the value of resistance.