Unit-1:-

Performance characteristics of instruments:-

- **Course Objectives:-** The student will

  1 . the instrument to be used based on the requirements.

  2. Understand and analyze different signal generators and analyzers

  3. Understand the design of oscilloscopes for different applications.

  4. Understand the principle of operation and working of various types of bridges for

  5. measurement of parameters

Course Outcomes:- The student will be able to

1. Evaluate basics of measurement systems, principle of basic meter
2. Evaluate how a signal can be generated using different types of meters.
3. Investigate a signal / waveform with different oscillators.
4. Use bridges of many types and measure appropriate parameters.
5. Design different transducers for measurement of different parameters.

Two basic characteristics

- (a) Static characteristics
- (b) Dynamic characteristics

- ***<u>Static characteristics :-</u>***

- Static characteristics of an instrument are, in general , considered for instruments which are used to measure an unvarying process condition.

- All the static performance characteristics are obtained by one form or another of a process called calibration.

Related definitions or characteristics described below:-

- (1) Instrument
- (2) Measurement
- (3) Accuracy
- (4) Resolution
- (5) Precision
- (6) Expected value
- (7) Error
- (8) Sensitivity

- ***(1) Instrument:-***

It is used to determine the present value of the quantity under measurement.

- ***(2) Measurement:-***

The process of determining the amount , degree (or) capacity by comparison (direct (or) indirect) with the accepted standards of the system units being used.

- ***(3) Accuracy:-***

The degree of exactness (closeness) of a measurement compared to the expected (desired) value.

- ***(4) Resolution:-***

The smallest change in a measured variable to which an instrument will respond.

- ***(5) Precision:-***

A measurement of the consistency or repetability of measurement i.e., successive reading do not differ.

- ***(6) Expected value:-***

The design value , i.e., the most probable value that calculations indicate one should except to measure.

- ***(7) Error:-***

The deviation of the true value from the desired value.

- ***(8) Sensitivity:-***

The ratio of the change in o/p (response) of the instrument to change of i/p or measured variable.

Errors in measurement:-

- Measurement is the process of comparing an unknown quantity with an accepted standard quantity.
- It involves connecting a measuring instrument into the system under consideration & observing the resulting response on the instrument.
- The measurement thus obtained is a quantitative measure of the so-called "true value"(since it is very difficult to define the true value , the term "expected value" is used).
- Error may be expressed either as absolute (or) as percentage of error.
- Absolute error may be defined as the difference b/w the expected value of the variable & the measured value of the variable , or

$$e = Yn - Xn$$

Where

e=absolute error

Yn=expected value

Xn=measured value

$$\% \, error = \frac{Absolute\ value}{Expected\ value} \times 100$$

$$= \frac{e}{Y_n} \times 100$$

$$\% \, errror = c\,\frac{y_n - x_n}{y_n} \text{x}100$$

- It is more frequently expressed as a accuracy rather than error.

- $A = 1 - \left|\frac{y_n - x_n}{y_n}\right|$

Where A is the relative accuracy.

Accuracy is expressed as % accuracy

A= 100% - % error

A= A×100%

Where a is the % accuracy

a=100%-%error

a=Ax100%

TYPES OF STATIC ERRORS:-

- Static error of a measuring instrument is the numerical difference b/w the true value of a quantity & its value as obtained by measurement i.e., repeated measurement of the same quantity gives different indications.

- Static errors categorized as below

(1) Gross errors (or) human errors

(2) Systematic errors

(a) Instrumental errors

(b) Environmental errors

© Observational errors

(3) Random errors

(1) Gross errors (or) human errors:-

- These errors are mainly human mistakes in reading (or) in using instruments (or) errors in recording observations.
- Errors may also occur due to incorrect adjustment of instruments & computational mistakes. these errors cannot be treated mathematically.
- The complete elimination of gross errors is not possible, but one can minimize them.
- One of the basic gross errors that occurs frequently is the improper use of an instrument. The errors can be minimized by taking proper care in reading & recording the measurement parameter.

(2) Systematic errors:-

- These errors occur due to short comings of the instrument, such as defective (or) worn parts (or) effects of the environment on the instrument.

- A constant uniform deviation of the operation of an instrument is known as a systematic errors.

(a) Instrumental errors:-

- Instrumental errors are inherent in measuring instruments , because of their mechanical structure.

- Ex:- In the D'Arsonval movement , friction in the bearings of various moving components , irregular spring tensions, stretching of the spring , or reduction in tension due to improper handling (or) overloading of the instrument.

- Instrumental errors can be avoided by

(i) Selecting a suitable instrument for the particular measurement applications.

(ii) Applying correction factors after determining the account of instrumental errors.

(iii) Calibrating the instrument against a standard.

(b) **Environmental errors**:-

- Environmental errors are due to conditions external to the measuring device, including conditions in the area surrounding the instrument, such as the effects of change in temperature.

  Humidity,

  Barometric pressure (or)

  Magnetic (or) electrostatic fields.

- These errors can also be avoided by

  (a) Air conditioning

  (b) Hermetically sealing certain components in the instruments

  © Using magnetic shields

(iii) **Observational errors**:-

- This errors are errors introduced by the observer.
- The most common error is the parallax error introduced in reading a meter scale, & the error of estimation when obtaining a reading from a meter scale.
- *Ex:-* An observer may always introduce an error by consistently holding his head too far to the left while reading a needle & scale reading.
- Systematic errors can also be sub divided into

  (a) Static errors.

  (b) Dynamic errors.
- Static errors caused by limitations of the measuring device or the physical laws governing its behavior.
- Dynamic errors are caused by the instrument not responding fast enough to follow the changes in a measured.

(3) Random errors:-

- Random errors are generally an accumulation of a large no.of small effects & may be real concern only in measurements requiring a high degree of accuracy.

- Random errors can thus be treated mathematically.

Statistical Analysis:-

- Statistical analysis of measurement of data is imp because it allows an analytical determination of the uncertainty of the final test result.

- To make statistical analysis meaningful, a large no.of measurements is usually required.

(a) Arithmetic mean

(b) Deviation from the mean

© Avg deviations

(d) Standard deviations

€ Limiting errors

- **(a) Arithmetic mean:-**
- The arithmetic mean, also called the average or average value, is the quantity obtained by summing two or more numbers or variables and then dividing by the number of numbers or variables.
- The arithmetic mean is important in statistics.

$$\overline{X} = \frac{X_1 + X_2 + X_3 \ldots X_N}{N}$$

Where

$\overline{X} \longrightarrow$ the mean

$X_1 \longrightarrow$ the first value

$X_2 \longrightarrow$ the second value

$X_3 \longrightarrow$ the third value

$X_N \longrightarrow$ the last value

$N \longrightarrow$ the number of value

DATA: { 16, 17, 10, 13, 20, 18, 13, 14, 18 }

$$\overline{x} = \frac{16 + 17 + 10 + 13 + 20 + 18 + 13 + 14 + 18}{9}$$

$$\overline{x} = \frac{139}{9}$$

$\overline{x} = 15.444$ (rounded to three decimal places)

- **(b) Deviation from the mean**:-
- This is the departure of a given reading from the arithmetic mean of the group of readings.
- It the deviation of the 1st reading, x_1, is called d_1 & that of the 2nd reading is called d_2 & so on

$$d_1 = x_1 - \bar{x}$$

Similarly

$$d_n = x_n - \bar{x}$$

The deviation may be +ve (or) –ve .the sum of all the deviations must be zero.

Average deviation:-

- It is an indication of the precision of the instrument used in measurement.

- It is defined as the sum of the absolute value of the deviation divided by the no. of readings.

- Average deviation may be expressed as

$$D_{av} = \frac{|d_1|+|d_2|+|d_3|+\cdots+|d_n|}{n}$$

(or)

$$D_{av} = \frac{\Sigma|d_n|}{n}$$

Where

$$D_{av} = average\ deviation$$

$|d_1|, |d_2|, \dots |d_n|$= absolute value of deviations

n= total no. of readings

Standard deviation (or) Root mean square deviation

- The standard deviation of a infinite no. of data is the square root of the sum of all the individual deviations squared, divided by the no. of readings.

Standard deviation expressed as

$$\sigma = \sqrt{\frac{d_1^2+d_2^2+d_3^2+\cdots+d_n^2}{n}}$$

$$= \sqrt{\frac{d_n^2}{n}}$$

σ = standard deviation

This deviation is most imp factor in the statistical analysis of measurement data.

Limiting errors:-

Most manufacturers of meaning instruments specify accuracy with a certain % of a full scale reading.

Ex:- the manufacturer of a certain voltmeter may specify the instrument to be accurate with in ±2%. With full scale deflection. this specification is called the limiting error.

Dynamic characteristics:-

- *Def:-* The set of criteria defined for the instruments which are changes rapidly with time , is called dynamic characteristics.
- Instruments rarely respond instantaneously to change in the measured variables.
- Instead , they exhibit slowness (or) sluggishness due to such things as Mass , thermal capacitance , fluid capacitance or electric capacitance.
- In addition to this , pure delay in time is often encountered where the instrument waits for some reaction to take place.
- Such industrial instruments are nearly always used for measuring quantities that fluctuate with time.
- Therefore the dynamic & transient behaviour of the instrument is as important as the static behaviour.
- The dynamic behaviour of an instrument is determined by subjecting its primary element (sensing element) to some unknown & predetermined variations in measured quantity

The three most common variations in the measured quantity are as follows.

- **(1) <u>Step change</u>:-**

In which the primary element is subjected to an instantaneous & finite change in measured variable.

- **(2) <u>Linear change</u>:-**

In which the primary element is following a measured variable, changing linearly with time.

- **(3) <u>Sinusoidal change:-</u>**

In which the primary element follows a measured variable, the magnitude of which changes in accordance with a sinusoidal function of constant amplitude.

Types of dynamic characteristics:-

(i) Speed of response

(ii) Fidelity

(iii) Lag

(iv) Dynamic error.

- **(i) Speed of response:-**

It is the rapidity with which an instrument responds to changes in the measured quantity.

- **(ii) Fidelity:-**

It is the degree to which an instrument indicates the changes in the measured variable without dynamic error.

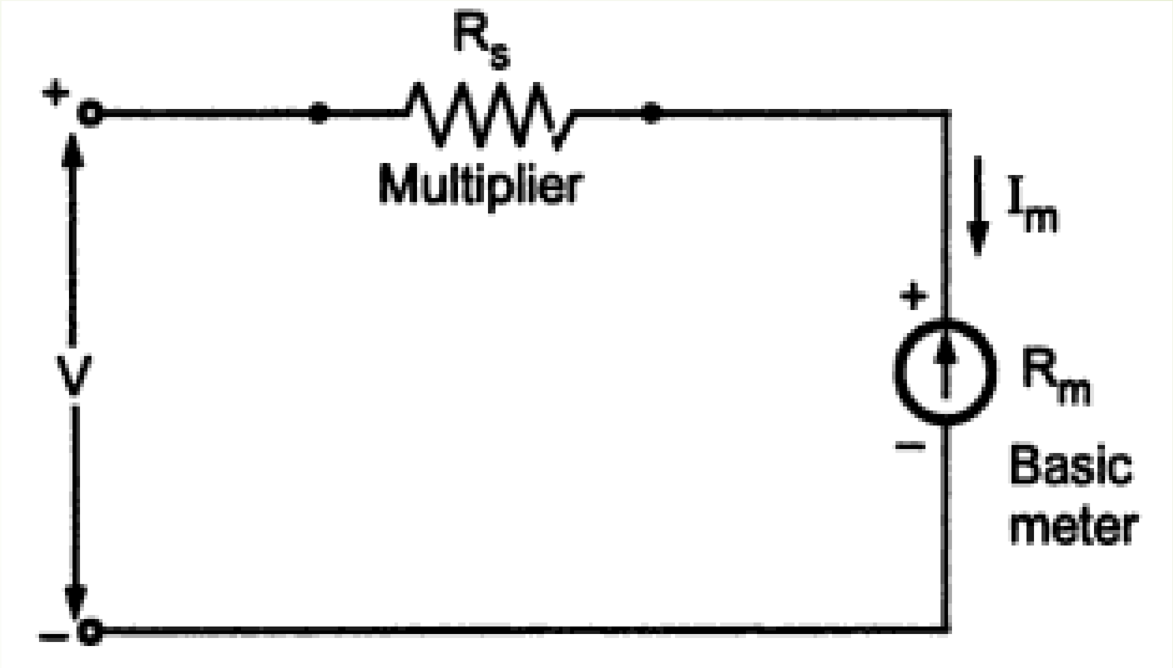
- **(iii) Lag:-**

It is the retardation or delay in the response of an instrument changes in the measured variable.

- **(iv) Dynamic error:-**

The dynamic relations b/w the instrument i/p & o/p are generally defined by the used of defferential eq's

DC voltmeter:-



- The basic D'Arsonval movement can be converted into a dc voltmeter by adding a series resistor known as multimeter.
- A basic d.c. meter uses a motoring principle for its operation. It stntes that any current carrying coil placed in a magnetic field experiences a force, which is proportional to the magnitude of current passing through the coil.
- This movement of coil is called D'Arsonval movement and basic meter is called D'Arsonval galvanometer.

The D'Arsonval Meter Movement

- The basic moving coil system generally referred to as a d'Arsonval meter movement or Permanent Magnet Coil (PMMC) meter movement.
- Current-sensitive device capable of directly measuring only very small currents.
- Its usefulness as a measuring device is greatly increased with the proper external circuitry.

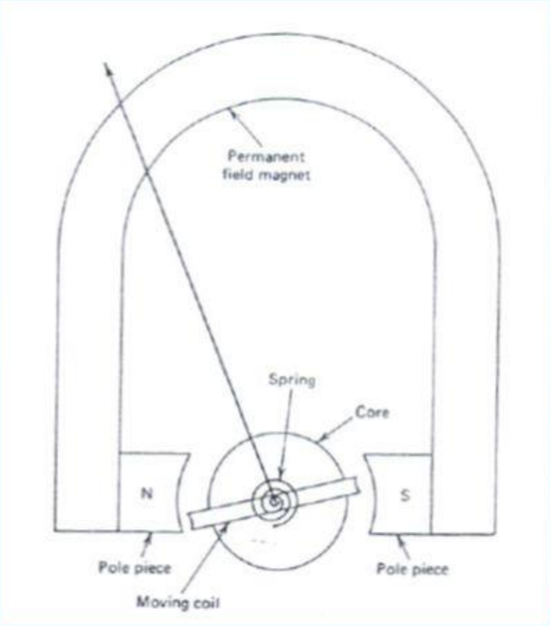
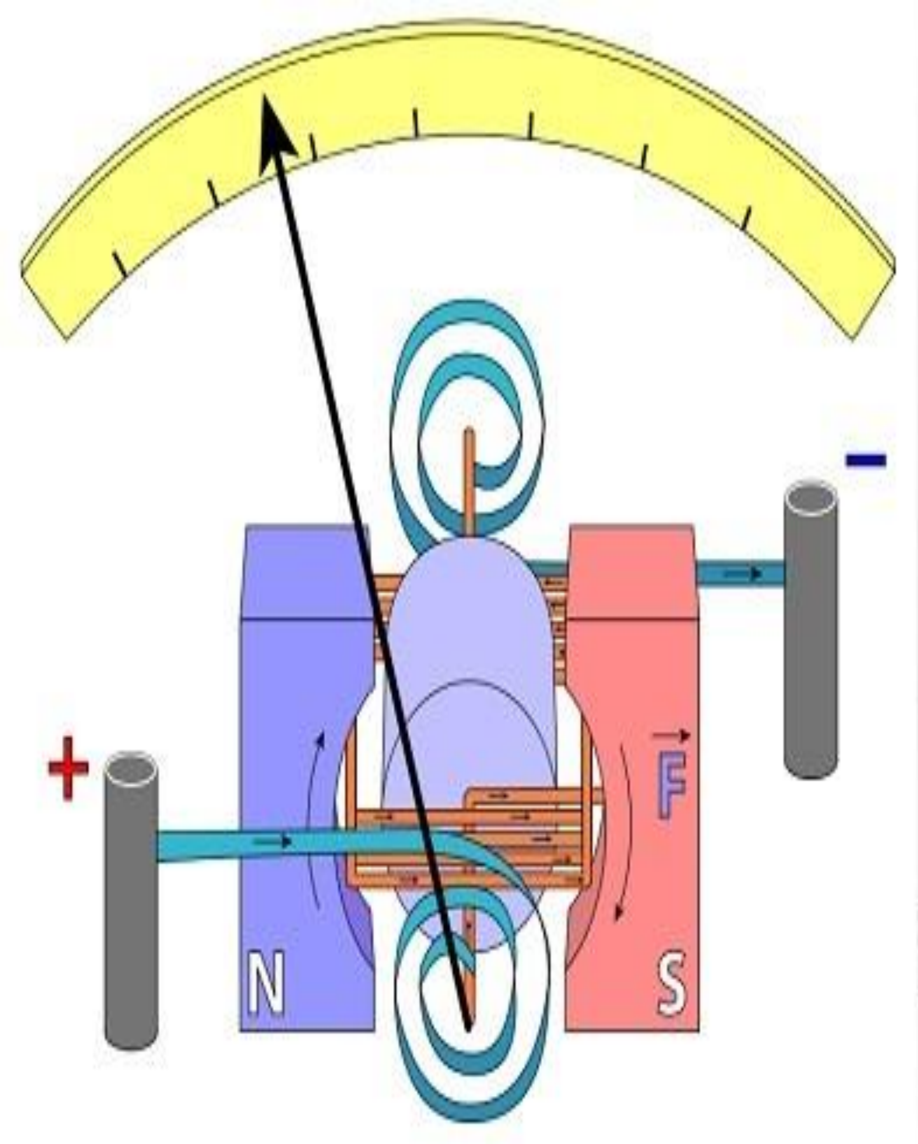
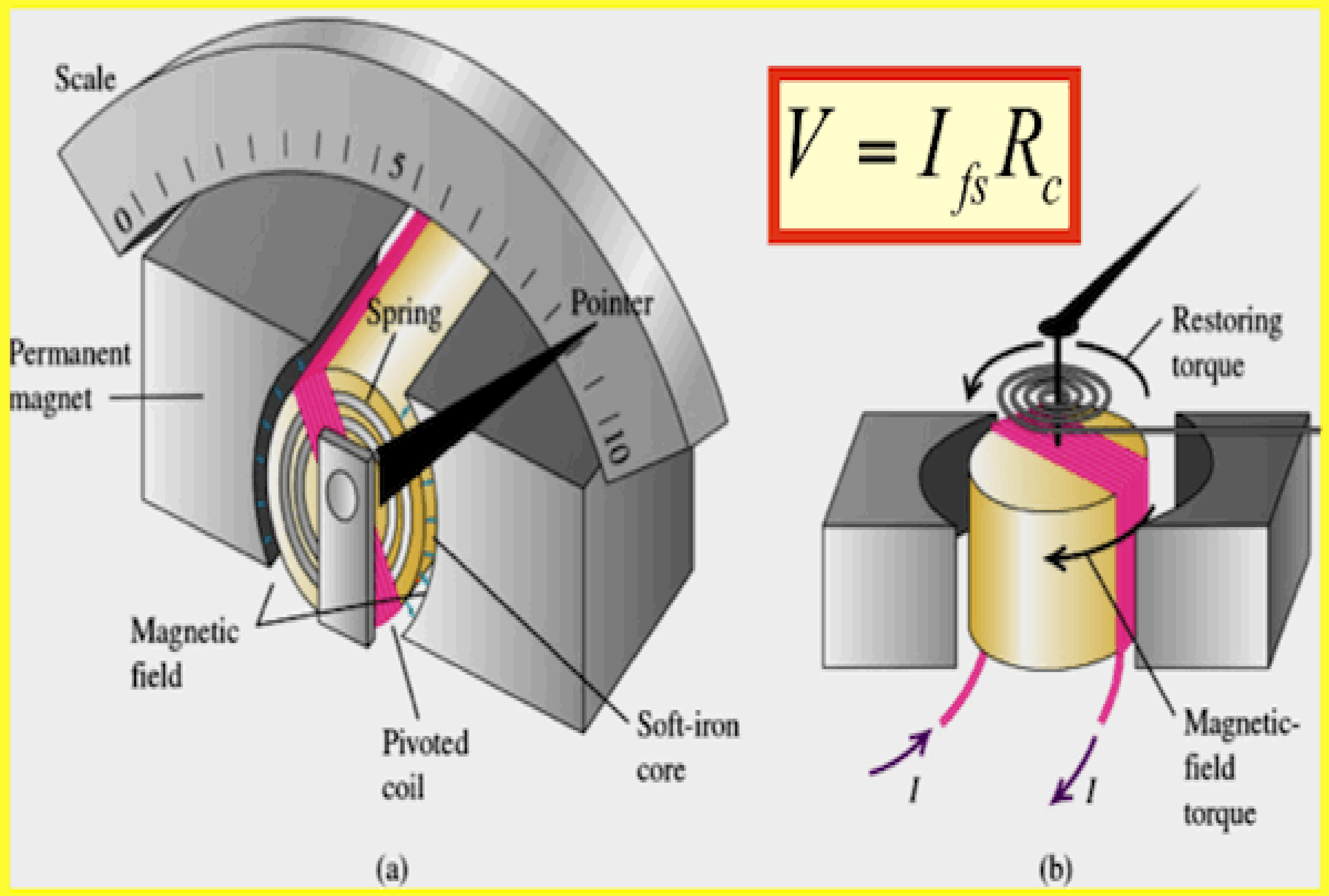


Fig 1-1 The d'Arsonval meter movement


+
−
N
S
F


Scale
0
5
10
Spring
Pointer
Permanent magnet
Magnetic field
Pivoted coil
Soft-iron core
(a)
$V = I_{fs} R_c$
Restoring torque
Magnetic-field torque
I
I
(b)

D'Arsonval galvanometer:-

- A **galvanometer** is an electromechanical instrument used for detecting and indicating an electric current.
- A galvanometer works as an actuator, by producing a rotary deflection (of a "pointer"), in response to electric current flowing through a coil in a constant magnetic field.
- Early galvanometers were not calibrated, but their later developments were used as measuring instruments, called ammeters, to measure the current flowing through an electric circuit.
- Galvanometers developed from the observation that the needle of a magnetic compass is deflected near a wire that has electric current flowing through it, first described by Hans Christian Ørsted in 1820. They were the first instruments used to detect and measure small amounts of electric currents.
- Sensitive galvanometers have been essential for the development of science and technology in many fields.
- For example, in the 1800s they enabled long range communication through submarine cables, such as the earliest transatlantic telegraph cables, and were essential to discovering the electrical activity of the heart and brain, by their fine measurements of current.

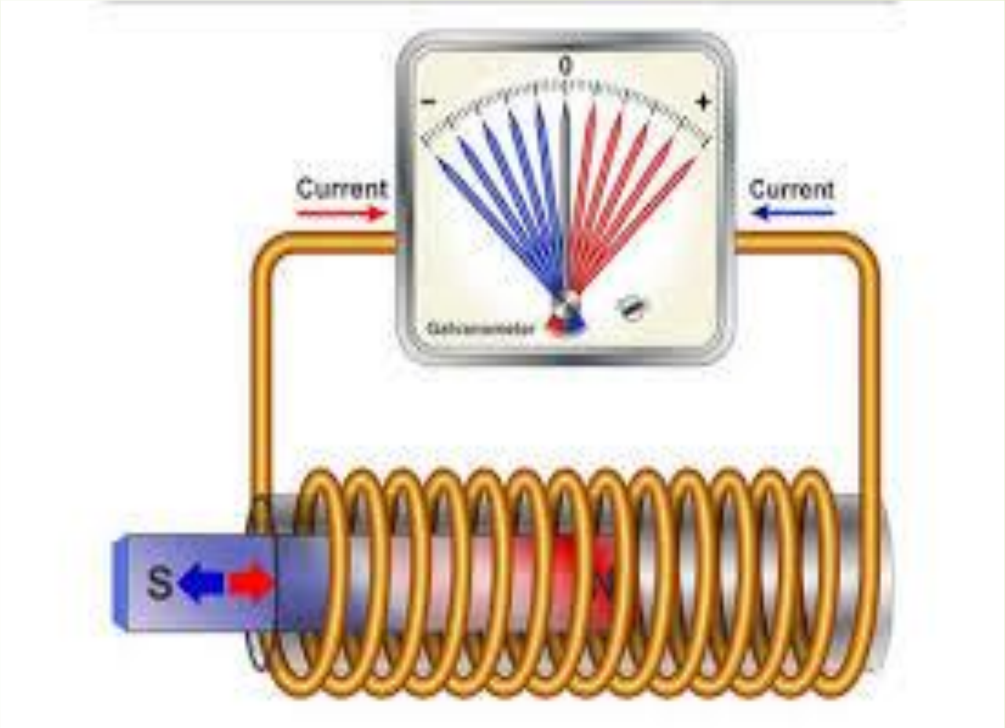
- Galvanometers also had widespread use as the visualising part in other kinds of analog meters, for example in light meters, VU meters, etc.,
- Today the main type of galvanometer mechanism, still in use, is the moving coil, D'Arsonval/Weston type.

Operation:-

- the D'Arsonval/Weston type, are constructed with a small pivoting coil of wire, called a spindle, in the field of a permanent magnet.
- The coil is attached to a thin pointer that traverses a calibrated scale. A tiny torsion spring pulls the coil and pointer to the zero position.
- When a direct current (DC) flows through the coil, the coil generates a magnetic field. This field acts against the permanent magnet.
- The coil twists, pushing against the spring, and moves the pointer. The hand points at a scale indicating the electric current.
- Careful design of the pole pieces ensures that the magnetic field is uniform, so that the angular deflection of the pointer is proportional to the current.

- The basic sensitivity of a meter might be, for instance, 100 microamperes full scale (with a voltage drop of, say, 50 millivolts at full current).
- Such meters are often calibrated to read some other quantity that can be converted to a current of that magnitude. The use of current dividers, often called shunts, allows a meter to be calibrated to measure larger currents.
- A meter can be calibrated as a DC voltmeter if the resistance of the coil is known by calculating the voltage required to generate a full scale current.
- A meter can be configured to read other voltages by putting it in a voltage divider circuit.
- This is generally done by placing a resistor in series with the meter coil. A meter can be used to read resistance by placing it in series with a known voltage (a battery) and an adjustable resistor.
- In a preparatory step, the circuit is completed and the resistor adjusted to produce full scale deflection.
- When an unknown resistor is placed in series in the circuit the current will be less than full scale and an appropriately calibrated scale can display the value of the previously unknown resistor.

- the pointer of the meter is usually a small distance above the scale of the meter, parallax error can occur when the operator attempts to read the scale line that "lines up" with the pointer.
- To counter this, some meters include a mirror along the markings of the principal scale.
- The accuracy of the reading from a mirrored scale is improved by positioning one's head while reading the scale so that the pointer and the reflection of the pointer are aligned; at this point, the operator's eye must be directly above the pointer and any parallax error has been minimized.


0
Current
Current
S
Galvanometer

D.C instruments:-

- Using shunt resistance, d.c current can be measured. The instrument is d.c microammeter, milliammeter or ammeter.

- b) Using series resistance called multiplier, d.c. voltage can be measured. The instrument is d.c millivoltmeter, voltmeter or kilovoltmeter.

.

- c) Using a battery and resistive network, resistance can be measured. The instrument is ohmmeter.

A.C instruments:-

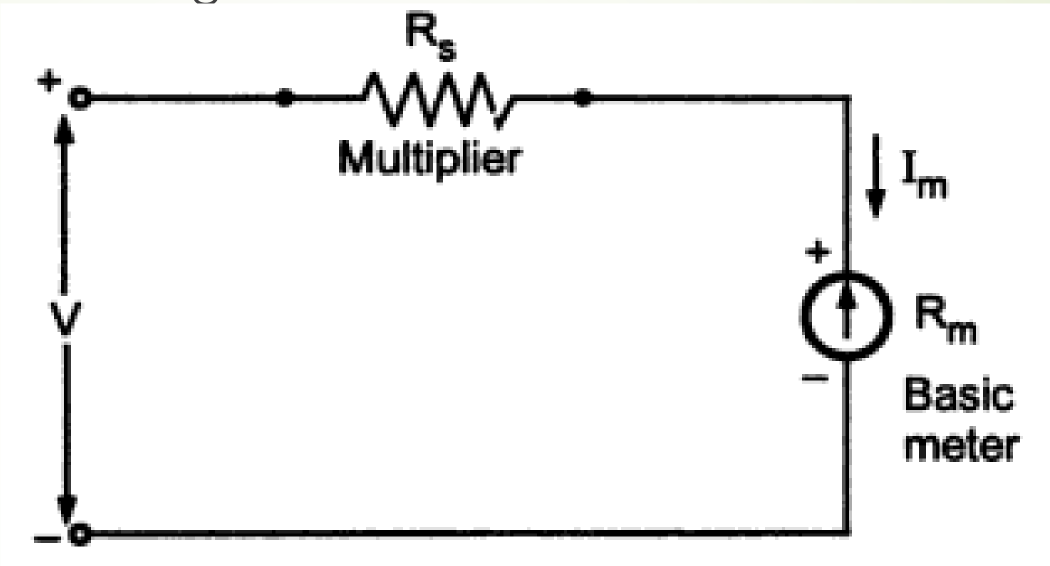
- a) Using a rectifier, a.c voltages can be measured, at power and audio frequencies. the instrument is a.c voltmeter.

b) Using a thermocouple type meter radio frequency (RF) voltage or current can be measured.

- c) Using a thermistor in a resistive bridge network, expanded scale for power line voltage can be obtained.

Basic DC voltmeter:-

- Basic dc voltmeter diagram



- The basic d.c voltmeter is nothing but a permanent magnet moving coil (PMMC) 0' Arsonval galvanometer.
- The resistance is required to be connected in series with the basic meter to use it as a voltmeter. This series resistance is called a multiplier.

- The main function of the multiplier is to limit the current through the basic meter so that the meter current does not exceed the full scale deflection value.
- The voltmeter measures the voltage across the two points of a circuit or a voltage across a circuit component.
- The voltmeter must be connected across the two points or a component, to measure the potential difference, with the proper polarity.
- The multiplier resistance can be calculated as:

I_m=full scale deflection current of the movement(I_{fsd})

R_m=Internal resistance of movement

R_s=Multiplier resistance

V=full range voltage of the instrument

From the above ckt

V=$I_m(R_s + R_m)$

V=$I_m R_s + I_m R_m$

Apply KVL around the loop of above ckt

$I_m R_s$ = V- $I_m R_m$

R_s=$\frac{V - I_m R_m}{I_m}$

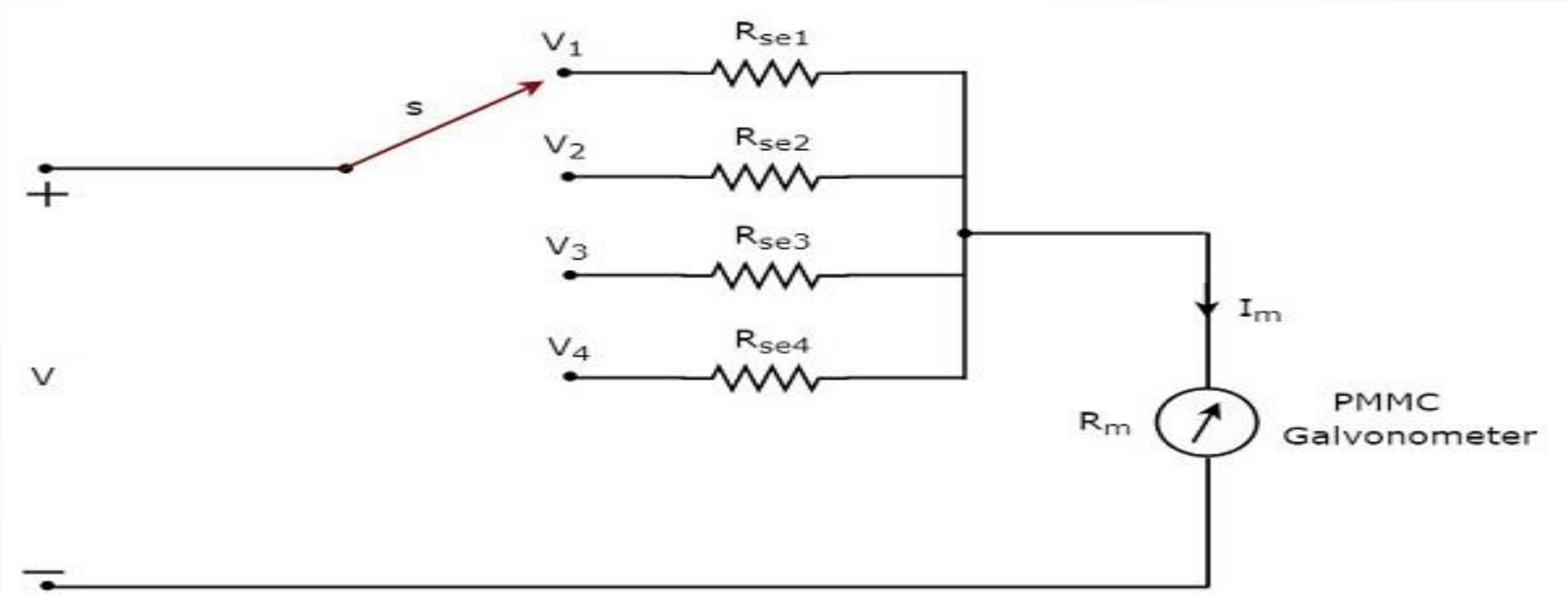
R_s=$\frac{V}{I_m} - R_m$

The multiplier limits the current through the movement, so as to not exceed the value of the full scale deflection I_{fsd}.

- The R1, R2, R3 and R4 are the four series multipliers. When connected in series with the meter, they can give four different voltage ranges as V1, V2, V3, and V4.
- The selector switch S is multiposition switch by which the required multiplier can be selected in the circuit.
- Similarlly ,a d.c voltmeter can be converted into a multirange voltmeter by connecting a no.of resistors (multipliers) along with a range switch to provide a greater no.of workable ranges.
- This arrangement is disadv compared to the previous one , because all multiplier resistances except the first have the standard resistance value are also easily available in precision tolerances.
- The first resistor or low range multiplier, R4 , is the only special resistor which as to be specially manufactured to meet the ckt requirements.

➨ ***Multi Range DC Voltmeter:-***

- In previous section, we had discussed DC voltmeter, which is obtained by placing a multiplier resistor in series with the PMMC galvanometer. This DC voltmeter can be used to measure a **particular range** of DC voltages.
- If we want to use the DC voltmeter for measuring the DC voltages of **multiple ranges**, then we have to use multiple parallel multiplier resistors instead of single multiplier resistor and this entire combination of resistors is in series with the PMMC galvanometer. The **circuit diagram** of multi range DC voltmeter is shown in below figure.



- We have to place this **multi range DC voltmeter** across the two points of an electric circuit, where the DC voltage of required range is to be measured. We can choose the desired range of voltages by connecting the switch s to the respective multiplier resistor.
- Let m1,m2,m3, and m4 are the multiplying factors of dc voltmeter when we consider full range dc voltages to be measured as V1,V2,V3 & V4 respectively.
- Following are the formulae corresponding to each multiplying factor.

$$m1=V1/Vm$$

$$m2=V2/Vm$$

$$m3=V3/Vm$$

$$m4=V4/Vm$$

In above circuit, there are four **series multiplier resistors**, R1,R2,R3 & R4.

Following are the formulae corresponding to these four resistors.

$$R1=Rm(m1-1)$$

$$R2=Rm(m2-1)$$

$$R3=Rm(m3-1)$$

$$R4=Rm(m4-1)$$

So, we can find the resistance values of each series multiplier resistor by using above formulae.

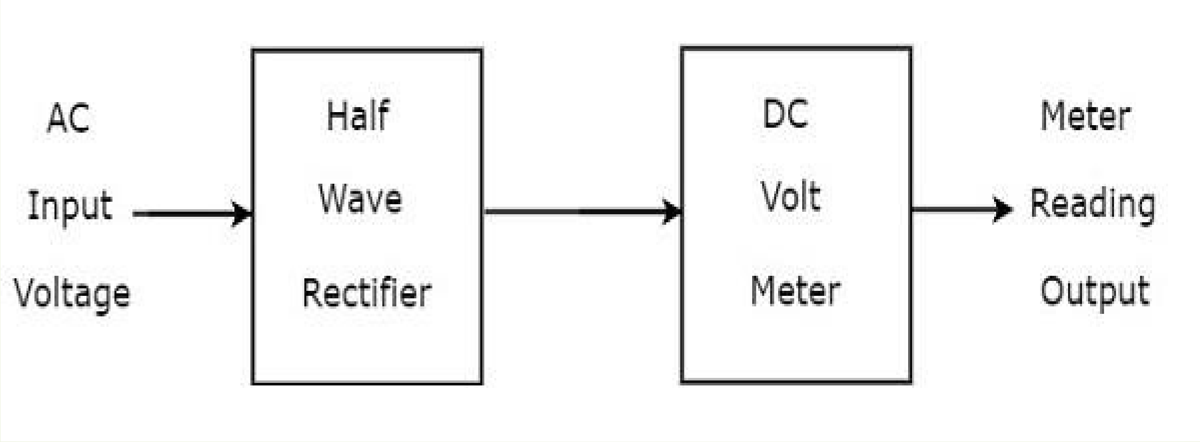
The instrument, which is used to measure the AC voltage across any two points of electric circuit is called **AC voltmeter**. If the AC voltmeter consists of rectifier, then it is said to be rectifier based AC voltmeter.

The DC voltmeter measures only DC voltages. If we want to use it for measuring AC voltages, then we have to follow these two steps.

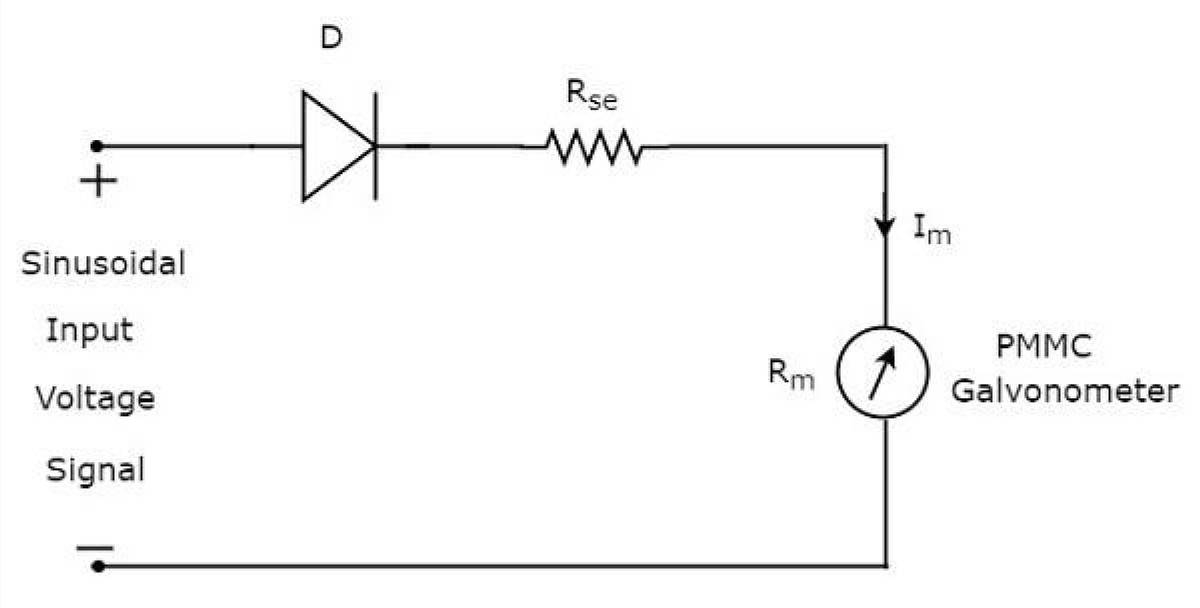
- **Step1** − Convert the AC voltage signal into a DC voltage signal by using a rectifier.
- **Step2** − Measure the DC or average value of the rectifier's output signal.

We get **Rectifier based AC voltmeter**, just by including the rectifier circuit to the basic DC voltmeter. This chapter deals about rectifier based AC voltmeters.

- Types of Rectifier based AC Voltmeters
- Following are the **two types** of rectifier based AC voltmeters.
- AC voltmeter using Half Wave Rectifier
- AC voltmeter using Full Wave Rectifier
- Now, let us discuss about these two AC voltmeters one by one.
- AC Voltmeter using Half Wave Rectifier
- If a Half wave rectifier is connected ahead of DC voltmeter, then that entire combination together is called AC voltmeter using Half wave rectifier. The **block diagram** of AC voltmeter using Half wave rectifier is shown in below figure.



- The above block diagram consists of two blocks: half wave rectifier and DC voltmeter. We will get the corresponding circuit diagram, just by replacing each block with the respective component(s) in above block diagram. So, the **circuit diagram** of AC voltmeter using Half wave rectifier will look like as shown in below figure.



Range Extesion voltmeters:-

- Diagram

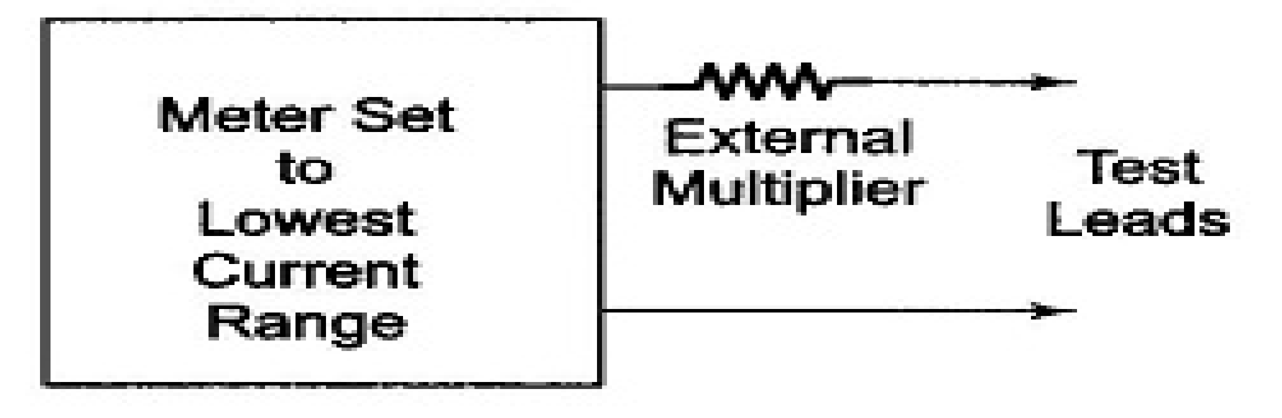


Fig. 4.4 Extending Voltage Range

- The range of a voltmeter can be extended to measure high voltages, by using high voltage probe (or) by using an external multiplier resistor.
- In most meters the basic movement is used on lowest current range values for multiplier can be determined using the multirange operation.
- The basic movement can be used to measure very low voltages.

Sensitivity:-

- The sensitivity or ohms per volt rating of a voltmeter is the ratio of the total ckt resistance R_t to the total voltage range.
- The sensitivity is essentially the reciprocal of the full scale deflection current of the basic movement.

$$S=\frac{1}{I_{fsd}} \text{ ohm/v}$$

- The sensitivity 'S' of the voltmeter has the adv that it can be used to calculate the value of multiplier resistors in a d.c voltmeter.

R_t= total ckt resistance[R_t= $R_s + R_m$]

S=Sensitivity of voltmeter in ohm/v

V=Voltage range as set by range switch

R_m=internal resistance of the movement

R_s= R_t- R_m & R_t=S×V

R_s= (S×V)- R_m

A.C voltmeter using fullwave rectifier:

- Diagram

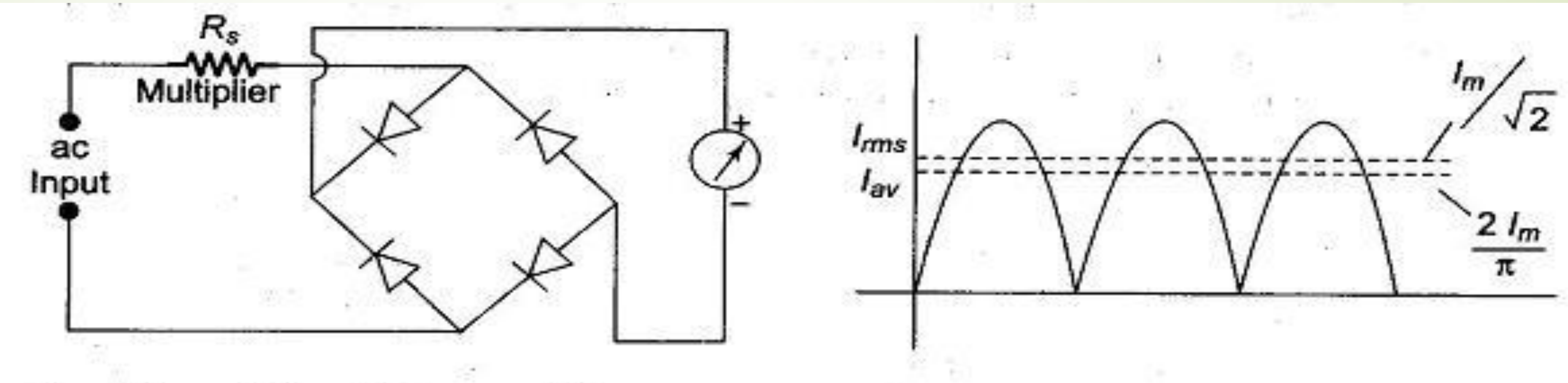


Fig. 4.16 (a) ac Voltmeter (b) Average and RMS Value of Current

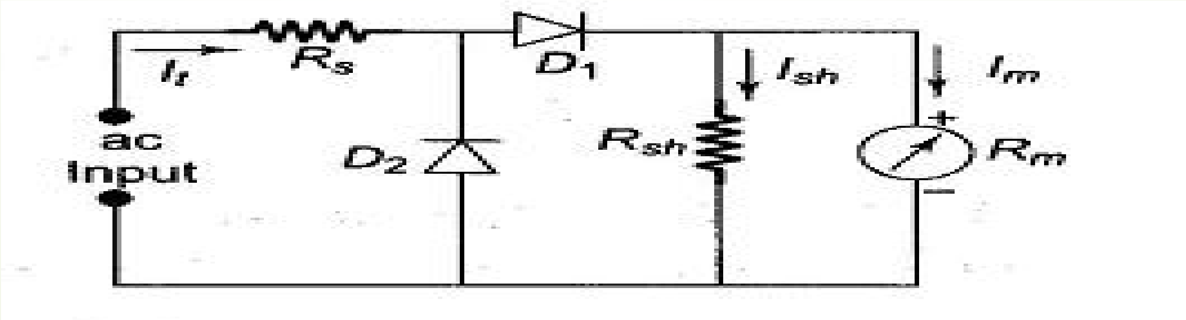


Fig. 4.17 General Rectifier Type ac Voltmeter

- Rectifier type instruments generally use a permanent magnet moving coil (PMMC) movement along with a rectifier arrangement.

- Silicon diodes preferred because of their low reverse current & high forward current ratings.

- The bridge rectifier provides full wave pulsating d.c . Due to the inertia of the movable coil , the meter indicates a steady deflection proportional to the avg value of current.

- The meter scale is usually calibrated to give the RMS value of an alternating sine wave i/p.

- The rectifier exhibits capacitance properties when reverse bias , &tends to bypass higher freq's.

- The meter reading may be in error by as much as 0.5% decrease for every 1KHZ rise in freq's.

- Diode D1 conducts during the +ve half of the i/p cycle & causes the meter to deflect according to the avg value of this half cycle.

- The meter movement is shunted by a resistor , R_{sh} , in order to drawn more current through the diode D1 & move the operating point into the linear position of the characteristic curve.

- In the –ve half cycle, diode D2 conducts & the current through the measuring ckt , which is in an opposite direction , bypass the meter movement.

True RMS Responding AC Voltmeter:-

- As the name suggests, the true RMS responding AC voltmeter responds to the true RMS values of AC voltage signal. This voltmeter measures RMS values of AC voltages. The **circuit diagram** of true RMS responding AC voltmeter is shown in below figure.

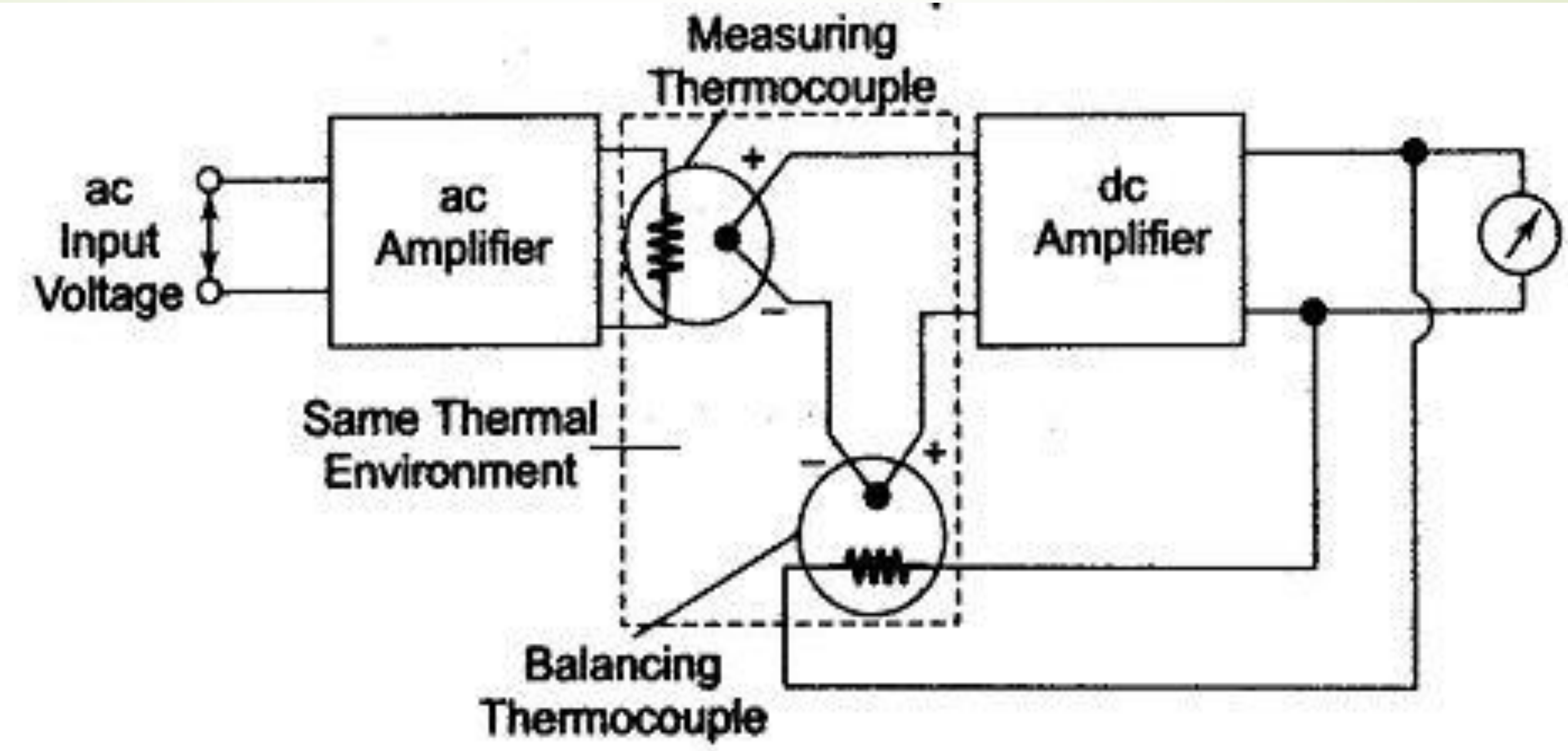


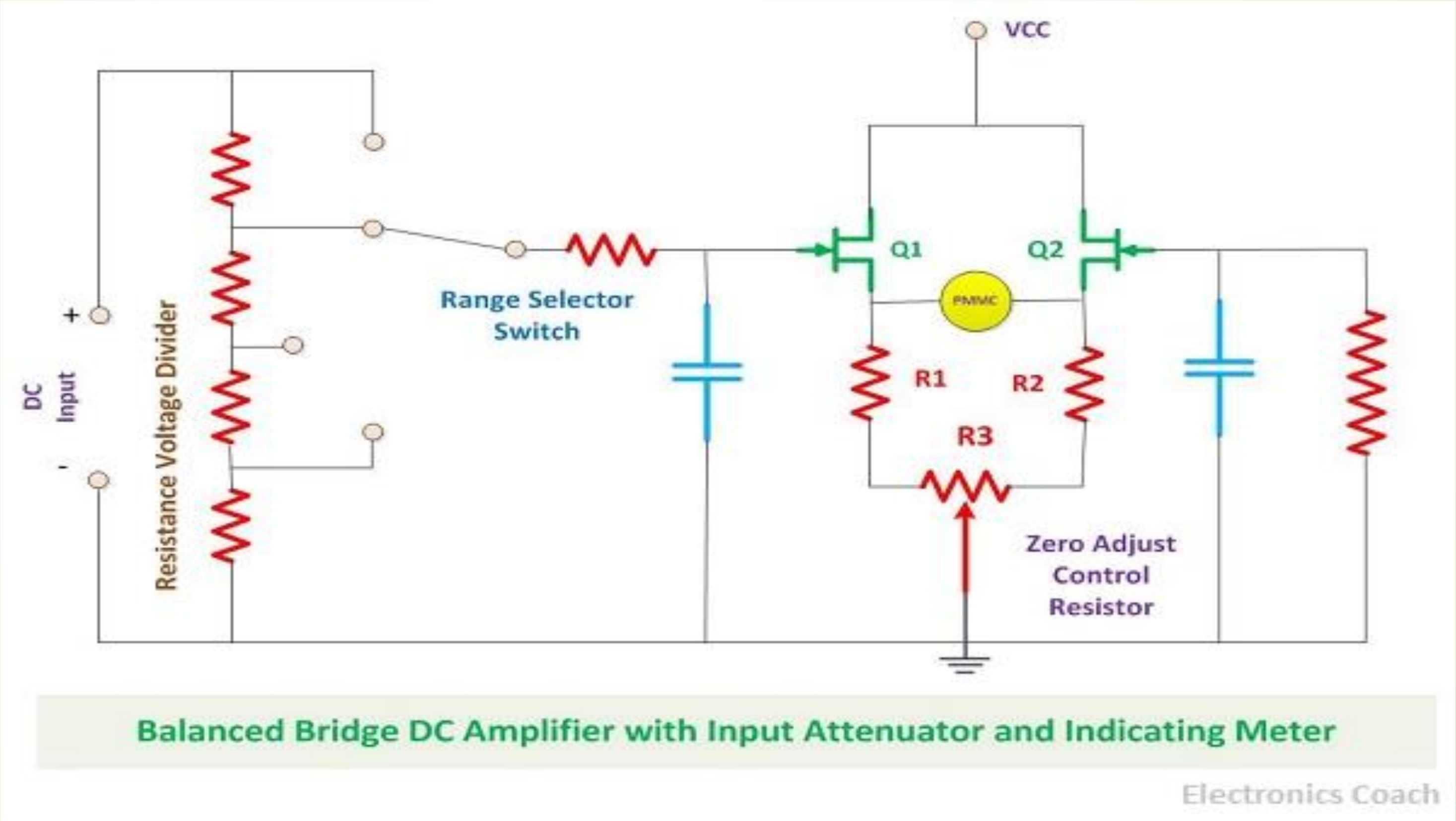
Fig. 4.25 True RMS Voltmeter (Block Diagram)

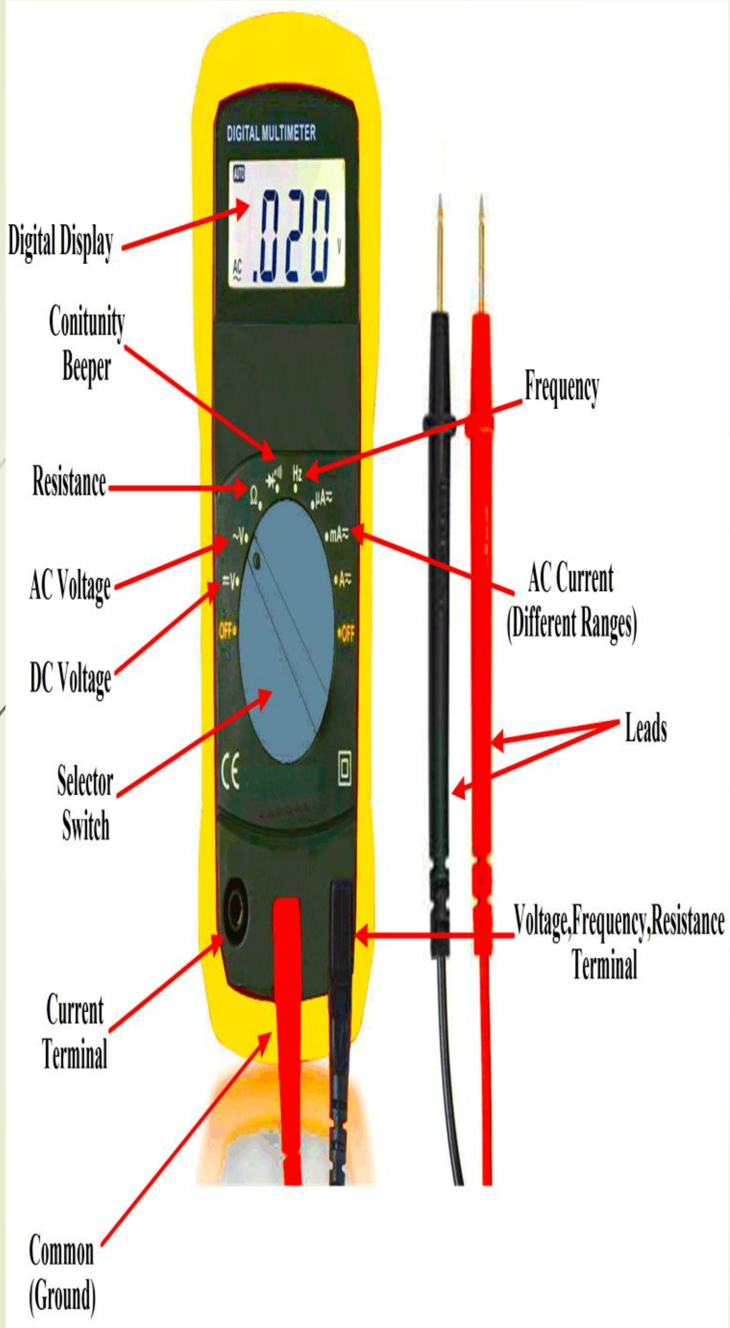
- The above circuit consists of an AC amplifier, two thermocouples, DC amplifier and PMMC galvanometer. AC amplifier amplifies the AC voltage signal.
- Two thermocouples that are used in above circuit are a measuring thermocouple and a balancing thermocouple.
- **Measuring thermocouple** produces an output voltage, which is proportional to RMS value of the AC voltage signal.
- Any thermocouple converts a square of input quantity into a normal quantity. This means there exists a non-linear relationship between the output and input of a thermocouple.
- The effect of non-linear behavior of a thermocouple can be neglected by using another thermocouple in the feedback circuit.
- The thermocouple that is used for this purpose in above circuit is known as **balancing thermocouple**.

- The two thermocouples, namely measuring thermocouple and balancing thermocouple together form a bride at the input of DC amplifier.
- As a result, the meter always responds to the **true RMS value** of AC voltage signal.
- The dc amplifier amplifies the unbalanced voltage; this voltage is fed back to the heating element of the balancing thermocouple, which heats the thermocouples, so that the bridge is balanced again i.e., the o/p's of both the thermocouples are the same.
- At this instant, the ac current in the i/p thermocouple is equal to the dc current in the heating element of the feedback thermocouple.
- This dc current is therefore directly proportional to the effective or rms value of the i/p voltage, & is indicated by the meter in the o/p ckt of the dc amplifier.
- If the peak amplitude of the ac signal does not exceed the dynamic range of the ac amplifier, the true rms value of the ac signal can be measured independently.

Electronic Multimeter:-

- It is a device which is used for the measurement of various electrical & electronic quantities such as current, voltage, resistance etc.
- Digram




DIGITAL MULTIMETER
Digital Display
Conituity Beeper
Resistance
AC Voltage
DC Voltage
Selector Switch
Current Terminal
Common (Ground)
Frequency
AC Current (Different Ranges)
Leads
Voltage,Frequency,Resistance Terminal


MADE IN JAPAN
AC10V
C(μF)
NULL
ICEO
LV
±DCV
LI(μA.mA)
LV(V)
sanwa
MULTITESTER
YX360TRF
20KΩ/V DC
9KΩ/V DC250V UP
9KΩ/V AC
DROP PROOF
FUSE
DIODE
PROTECTION
NULL METER
SANWA ELECTRIC INSTRUMENT CO.,L
DCV
DCV(NULL)
ACV
0ΩADJ
HV PROBE
C(μF)
×100kΩ
OFF
DCA
hFE PROBE
MAX
DC 1000V
AC 750V


000
AUTO POWER OFF
ON/OFF
PNP
NPN
hFE
TEMP
Cx
F
Hz
IEC 1010
10A
mA
COM
VΩHz
20A 15SEC MAX
UNFUSED
200mAMAX
FUSED
CAT III 600V
CAT II 1000V
velleman
DVM890F

Definition: -

- The **Electronic Multimeter** is a device which is used for the measurement of various electrical and electronic quantities such as current, voltage, resistance etc. The multimeter name is given to it to define its ability to measure multiple quantities.

- It is provided with inbuilt power supply necessary for the functioning of the device. Any component such as a resistor, battery can be connected to its outer probes for the measurement of the electronic quantity.

- In order to understand how a single meter can measure multiple electrical quantities, we need to look into its constructional feature and the components which make it a multimeter.

Construction and Components of Multimeter:-

- The multimeter basically consists of a **bridge DC amplifier, rectifier, PMMC meter, function switch, internal battery** and an **attenuator.**

- The function of the attenuator is that it helps to select a particular range of voltage values.

- The rectifier is essential in a multimeter for the conversion of AC voltage into DC voltage. The internal battery is needed for the operational mechanism of the multimeter.

- The Bridge DC amplifier is nothing but two Field effect transistor connected opposite to each other with three resistors and forming a bridge-like structure.

- The two resistors are for balancing the bridge, and the third resistor is a zero adjust control resistor.

Working of the Multimeter:-

- The Multimeter performs its operation by providing the input voltage to the gate terminal of the **FET,** and this gate voltage is responsible for the increase in the source voltage of the FET. The **PMMC meter** is connected between the two FET.
- In the ideal condition, no current should flow from PMMC meter so thus it must show zero deflection, but in the practical implementation, the PMMC meter shows some deflection. This is undesirable in steady state.

- Thus a **zero adjusts control resistor** is used for adjusting the value of current to zero. After this again, the PMMC shows no deflection.

- But make sure the above condition is defined when no input is applied to it. When the input is applied to it either by connecting a resistor or any other component, the circuit switched to the active state and the changes in the circuit due to the connection of the component is deflected with the help of PMMC meter.

- There are series of steps which is to be followed while measurement. First, the multimeter should be tested whether is it working or not. If it is not working the battery requirements of the device should be checked.

- After this, we need to set the knob of the multimeter to set it on the values or quantity which is to be measured. For example, if we want to measure resistance then the multimeter should be set to option **“ohm”**. Apart from this, we need to set the range of multimeter.

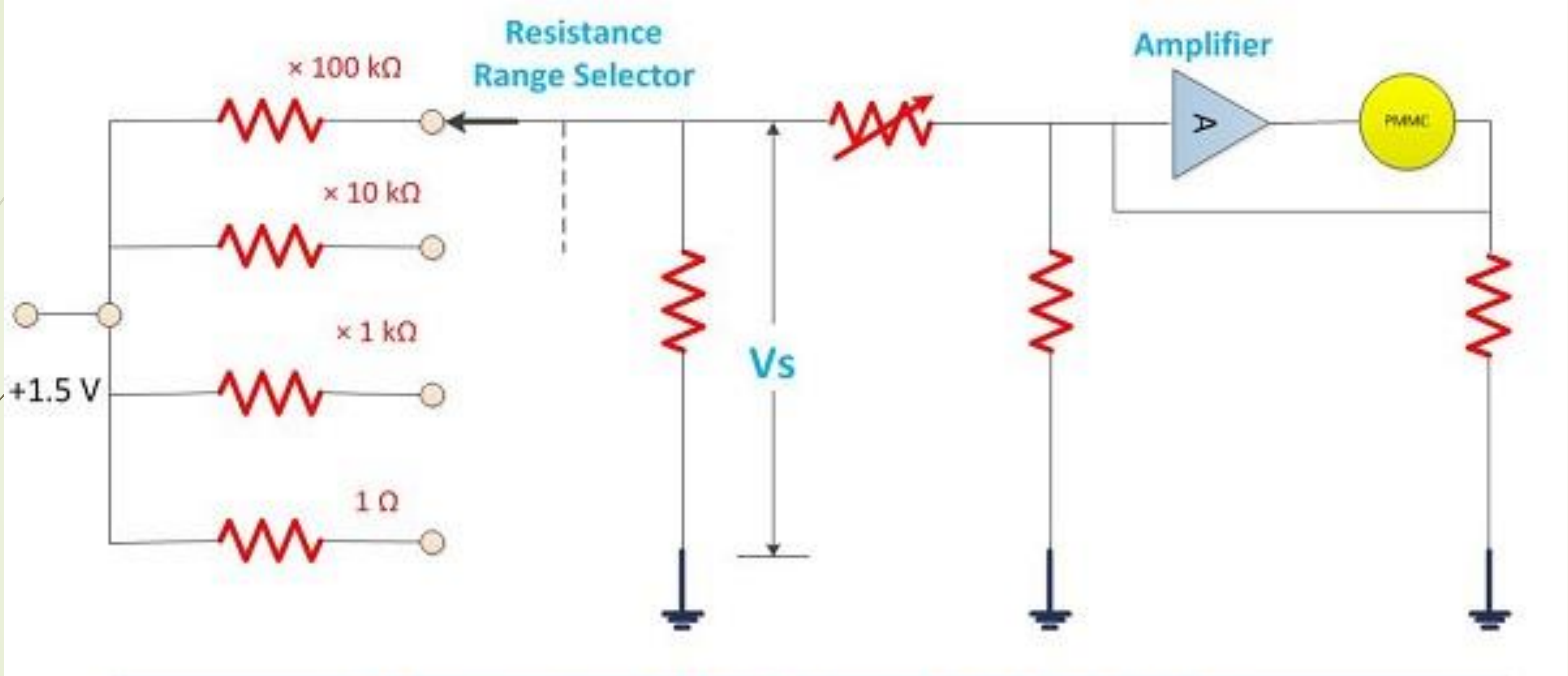
- It is significant to set the range of multimeter because if you are measuring the resistance of the resistor which possesses value in kilo-ohms and the range of multimeter is not set and by default it is in ohm or mega-ohms, then you will get wrong results. Therefore it is crucial to set the range of the multimeter properly.

Measurement of Resistance by Multimeter:-

- The resistance can be measured by multimeter easily by connecting the two probes of the multimeter with two ends of a resistor. The unknown resistor the resistance of which is to be measured is connected to the function switch and the battery.

- The battery of 1.5 V is connected to the circuit when the resistor is connected the circuit becomes complete, and the voltage across the resistor is measured by the circuit, and the particular range is indicated by the PMMC meter.

- There are various resistors that are connected in parallel; all these resistors possess different values of resistance. The range which is to be measured can be set and also a particular range of value of resistance can be connected to the unknown resistor.



Measurement of Resistance by a Multimeter

- The Amplifier connected in series amplifies the signal. The signal gets distorted as it passes through the circuit.
- Moreover, the current also flows from that path in which the resistor is connected. And we all are aware of the fact that the value of voltage drop across the resistor is directly proportional to the value of the resistor.
- Thus, as the value of resistance increases the value of the voltage drop across it increases, and thus the PMMC meter shows the deflection accordingly. In this way, the value of resistance is measured.