Performance characteristic of Instrument :—

The problem with any measuring instrument is error. Hence it is necessary to select the appropriate instrument and measuring processor which minimize the error.

Static characteristic	dynamic characteristic
Accuracy	speed of response
Resolution	fedility
precision	Lag
expected Value	Dynamic Error
error	
sensitivity	

Static characteristic :—

It is defined for the Instrument used to measure the Quantity which is independent of time.

Accuracy :—

The degree of closeness of measured ~~Quality~~ Quantity to the true value is known as accuracy

$A_t = 5V \rightarrow$ True value

$A_m = 4{\cdot}2V \rightarrow$ Measured value

$4{\cdot}8V$

$4{\cdot}99V \rightarrow$ More accuracy

$3{\cdot}5V \rightarrow$ Least accuracy

Resolution :—

It is the smallest observable change in Input then the instrument Can response is called resolution.

Ex:— If I/P is = 1V then O/P is = 2V

I/P		O/P
1V	0.2V	2V
1·1V		2V
1·2V		2·5
1·3V	0·2V	2·5
1·4V		3V

Here the observable change is 0.2V hence the resolution is 0.2V

$$R = \frac{\text{full scale ~~scale~~ Voltage}}{\text{total no: of divisions.}}$$

→ A Zero (0) to 10V voltmeter with number of division's of divisions of 100 and we ~~get~~ can estimate 1/10th of the scale divison very accurotly ?

$$R = \frac{10}{1000} = 0.01$$

$100 \times 10 = 1000$

Precision:—

The Most repetable Value or reproducable value among a set of records is called precision.

Ex:— $A_t = 10V$

$A_m =$ 9.1V, 9.2, 9.3, 9.4, 9.5 → low precision, low accuracy

9.9V, 9.9, 9.9, 9.7, 9.6 → high precision, high accuracy

9.1, 9.2, 9.2, 9.2, 9.6 → low accuracy, high accuracy

$$P = 1 - \left| \frac{x_n - \bar{x}_n}{\bar{x}_n} \right|$$

P – precision

x_n – nth Value of measurment

$\bar{x}_n$ – Average set of recorded

precision is supporting characteristic of accuracy.

The accurate instruments may be precises but precises will not Conform any Accuracy.

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Expected Value:—

The Most probable Value that calculation one should expect to measure.

The difference of Measured value to the true Value is known as error

$$E = A_m - A_t$$

$E \rightarrow$ error

$A_m \rightarrow$ Measure Value, $A_t \rightarrow$ true Value

E is +ve when $A_m > A_t$

E is -ve when $A_m < A_t$

Ex:— $A_t = 5V$

$A_m = 4.5$

$E = -0.5V$

We have to add or subtract some Quantity to the measured value inorder to get the true value is called as Correction factor (C_F)

If error +ve then C_F is -ve

If error -ve then C_F is +ve

Related Static error:—

The static error is taken Over a true value is called related static error

$$\% \, RSE = \frac{A_m - A_t}{A_t} \times 100$$

The % of RSE defines the Quality of Instrument

Limiting Error:— (or) UnCertainity (or) Tolerance

It is specified by Manfacture. It is alway taken w.r.t to true Value

for a Instrument limiting error is small and not be Zero

Instrument	Limiting error
A	±0.5%
B	±2%
C	±0.1%
D	±0.01%

$A_t \pm (\ )$ ↳ Limiting

Guarantee Accuracy Error:—

It is also specified by the Manufacture. GAE is always take w.r.t to fullscale Value. It is a Constant error seen by the Instrument. Since GAE is taken w.r.t full Scale Value.

→ A 0 to 10V Voltmeter with % of GAE of ±1% and true Value are 20V, 25V, 50V, 100V respectively then find the % of limiting error?

$$\% \text{ of } GAE = \pm 1\%$$

$$GAE = 100 \pm \frac{1}{100} = \pm 1V$$

$A_t = 20V$

$$20 \times \frac{x}{100} = \pm 1V$$

$$\% LE = x = \pm 5V$$

$A_t = 25V$

$$25 \times \frac{x}{100} = \pm 1V$$

$$x = \pm 4V$$

$A_t = 50V$

$$50 \times \frac{x}{100} = \pm 1V$$

$$x = \pm 2V$$

$A_t = 100V$

$$100 \times \frac{x}{100} = \pm 1V$$

$$x = \pm 1V$$

A_t	% LE	% GAE
20%	±5V	±1%
25%	±4V	±1%
50%	±2V	±1%
100%	±1V	±1%

$$A_t \uparrow \Rightarrow \% LE \downarrow \Rightarrow \text{Accuracy} \uparrow$$

Sensitivity:— It is defined as ratio of magnitude of output signal to magnitude of i/p signal.

$$S = \frac{\text{mag of o/p signal}}{\text{mag of i/p signal}}$$

When a small change in i/p will effect a large change in o/p signal, then the Instrument is called high sensitivity instrument

→ We always prefer high sensitivity instrument then we may note loose any accuracy

→ Sensitivity can also be expressed as

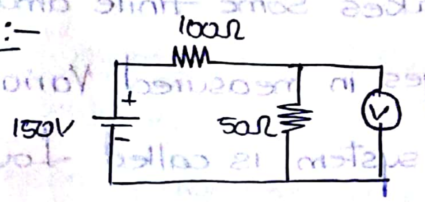
$$S = \frac{\Omega}{V}$$

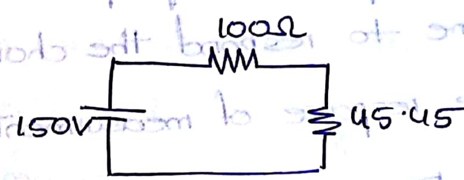
$$S = 1/V/\Omega$$

$$S = \frac{1}{I_{FSD}}$$ FSD:— full scale deflection current

Sensitivity ↑ → loading error ↓ → Accuracy ↑

Eg:—





Theoritical $V_{AB} = 150V \times \frac{50\Omega}{150\Omega} = 50V$

In Voltmeter $= \frac{50V \times 10\Omega}{1V} = 500\Omega$

50 || 500

$$\frac{50 \times 500}{550} = 45.45$$

$$V_{AB} = \frac{150 \times 45.45}{145.45} = 46.87$$

(ii) $S = \frac{100k\Omega}{1V}$

$$\frac{50V \times 100k\Omega}{1V} = 5000k\Omega$$

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$50 \| 5000k\Omega$

$$= \frac{50 \times 5000k}{50 + 5000k} = 49.99$$

$$V_{AB} = 150 \times \frac{49.99}{49.99} = 49.99$$

Loading error $= 50 - 49.99 = 0.01$

Type of errors :—

Dynamic Characteristic :—

i) Speed of response :— The rapidity with which an instrument can response to change in the measured quantity. It indicates how fast the system reacts to change I/p

ii) fedility :— It is defined as the degree to which an instrument indicates change in measured quantity without dynamic error.

iii) Lag :— Every system takes some finite amount of time to respond the changes in measured Variable in the response of measurment system is called Lag.

iv) Dynamic error :— It is the difference b/n true Value of the quantity changing w.r.t to time & the Value indicated by Measuring instrument, if no static error is assumed

- Error
  - Gross errors
  - systematic errors
    - Instrumental errors
    - Environment error
    - Observational error
  - Random error

Gross errors:— These are mainly due to human mistake such as improper reading, recording the reading differently in the calculation of results due to insufficient knowledge, improper use of an instrument.

→ This errors can't be treated mathematically & not possible to eliminate completely but these errors can be minimized by taken precautions.

→ By taking care of reading and recording in the calculation of results

→ By taking atleast 3 or more readings preferrably by different person.

Systematic errors:

These errors are mainly due to short coming of instruments characteristic of material used in instrument envinormental effect, aging effect etc.

These are further classified as: Instrumental
Envinormental
Observational

Instrumental error:— These errors are due to short coming of Instrument, misuse of instrument, loading effect etc

→ These error can be minimized by selecting a suitable instrument for a suitable application.

→ Applying the correction factor after finding the amount of instrumental error.

Envinormental error:— These error due to conditions external to the instruments such as temperature, pressure changes, external field magnetic or electrostatic fields, humidity or vibration etc.

→ These errors can be minimized by using airconditioning temperature enclosures to keep the surrounding conditions constant.

Use of magnetic or electrostatic shields to reduce the effect of external fields

→ Hermitically Celling of Certain Components to reduce the effect of humidity & dust

Observational error :—

These are introduced by the human.

→ The most Common error is parallexerror while reading a meter.

→ These Can be reduced by using instruments with mirror & knife edge painter

→ Using an instrument with digital display.

Random error :— These are due to unknown causes, even the instrument is calculated accurately then these errors are called random error

→ These Cannot be determined & they follows the law of probablity

→ The Only way to reduce these errors is by taking more observations & statistically analysis which gives the best approximation of reading.

Measurment :—

Measument is the process of Comparision b/n a pre-defined Standard & the Quantity to be measured, which results knowing the magnitude of Unknown Quantity.

Instrument :— It is a device which is used to measure the Quantity

Statistical Analysis:—

1) Arithematic mean:— The Algebric sum of reading divided by total no: of readings

$$\overline{X} = \frac{x_1 + x_2 + x_3 + \cdots + x_n}{n}$$

2) Deviation from mean:— The departure a given reading from Arithematic mean of set of records is called deviation

$$d_1 = x_1 - \overline{X}, \quad d_2 = x_2 - \overline{X}$$

3) Average Deviation:— The sum of absolute values of deviation divided by no: of reading is called average deviation.

$$D = \frac{|d_1| + |d_2| + \cdots + |d_n|}{n}$$

4) Standard deviation:— The square root of sum of square's of the deviation divided by no: of reading

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

5) Variance:—

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

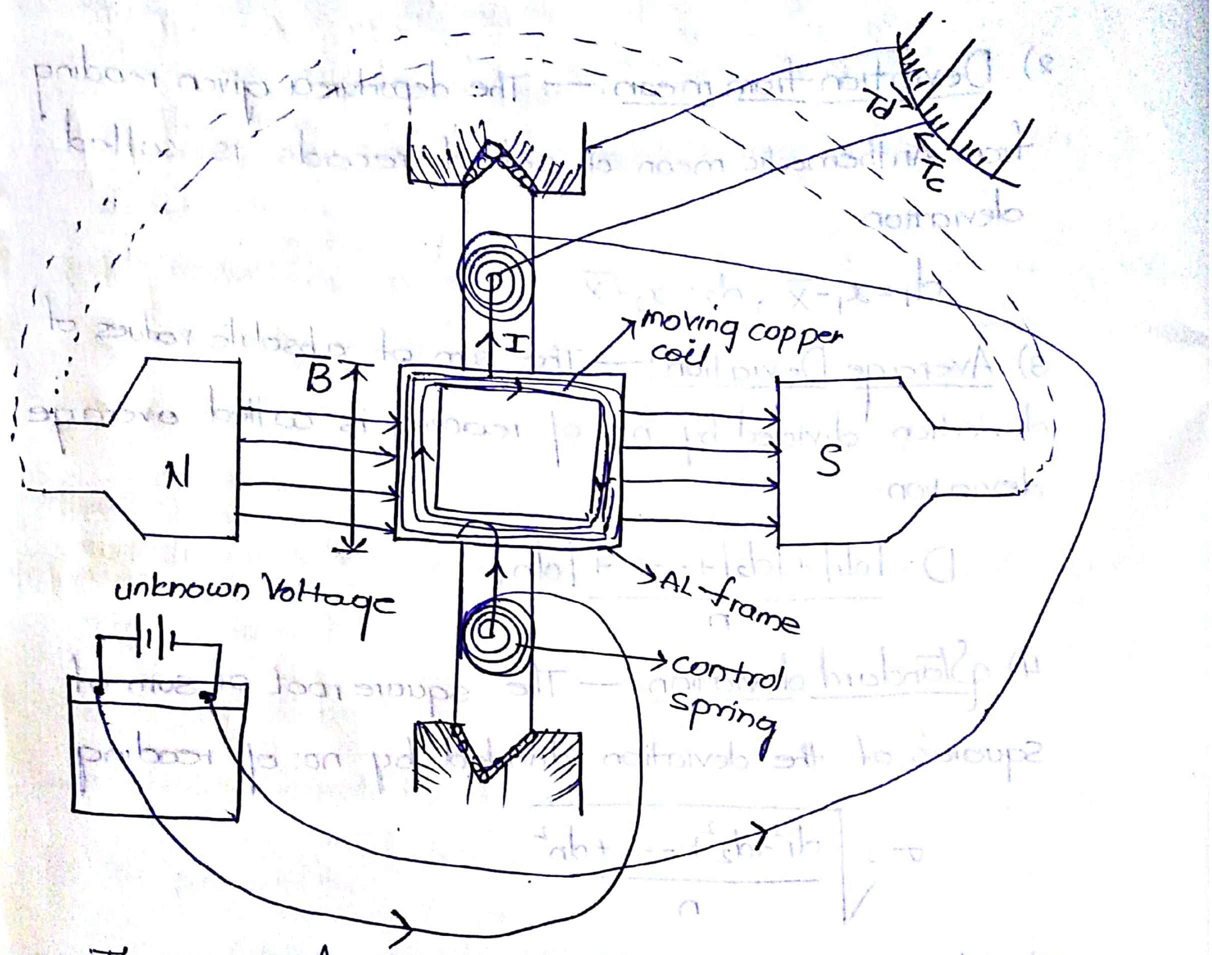
DC Instruments:— (PMMC Meter)

The operation of analog instruments such as ammeter and Voltmeter depends on deflection torque produced by an electric Current.

PMMC Instrument:— (permanent magnet moving coil)

The PMMC Instruments are used for measurements of DC Current and DC Voltage. This instrument uses the basic principle of DArsonval movement.

DArsonval Movement:— When a Current Carring coil is placed in a Magnetic field then the coil experience a force and moves. The amount of force developed by coil is directly propotional to Current passing through the Coil.



The PMMC Instrument Contains following forces

1) Deflection force and Deflection Torque:—

The force required to move the pointer from intial position is called deflecting force which is propotional to Current passing through coil in PMMC the scale is linear. hence the pointer deflections are propotional to deflecting torque which interms depends on Current through the coil.

2) Controlled Curve:—

It is equal and opposite to deflection torque. inorder to make pointer deflection propotional to magnitude of Quantity to be measured and which prevents the pointer for Continous rotation.

It is provided by two

It also brings the pointer to Zero position. When the force is removed.

Damping force (or) Curve:—

It is produced by eddy current in the metal form and which the Carrying coil is mounted.

Due to this force the panter Quickly reaches to final steady state without any swing or oscillations

$$V\uparrow, I\uparrow \rightarrow F\uparrow \rightarrow T_d\uparrow \rightarrow \theta\uparrow \rightarrow \text{tightness spring}\uparrow$$

$$\text{energy storage}\uparrow \rightarrow T_c\uparrow$$

The deflecting torque

$$T_d = NBAI$$

Where

N = no: of turns

B = Current Magnetic flux density in the Air gap

A = Area of coil

I = Current passing through the coil

The Controlling torque is given $T_c = K\theta$

k = spring constant

θ = deflection of the meter

$$T_c = T_d$$

$$K\theta = NBAI$$

$$\theta = \frac{NBAI}{K}$$

$$\theta \propto I$$

Advantages:—

1) Lowpower Consumption
2) Uniform scale
3) Measurment of DC which results high accuracy

4) The Magnetic field is produced by permanent magnet. hence the effect of stray magnetic fields eliminated.

Disadvantages:—

1) It is used only for DC Measurments

2) The Ac ~~grups~~ aging of permanent magnets and control springs introducing error.

3) The temperature and friction may also introduce error

Applications:—

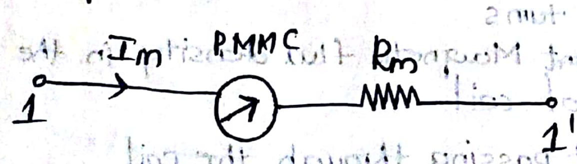
1) It Can be used as a DC Voltmeter by using a series resistor

2) It can be used as DC ammeter by using a shunt resistor

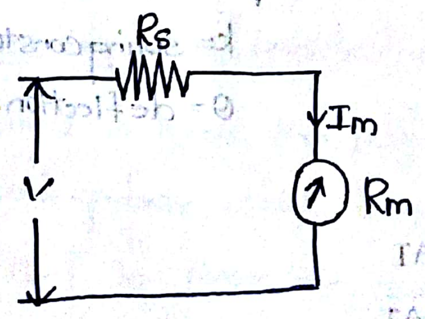
3) It Can be used as ohmmeter by using Voltage source and ammeter

4) It Can be used as radio frequency ammeter (or) Voltmeter by using a thermocoupler

Simple diagram of PMMC:—



Basic Dc Voltmeter:—



→ A DC Voltmeter is use to measure the potential difference between 2 point in a dc Circuit (or) ckt Component

→ The basic DArsonval movement is Converted into Voltmeter by using a Series resistor called as Multiplier

→ The function of multipliers is to limit the Current through the Basicmeter then the Current doesn't exceeds full Scale deflection Current

→ To Measure the potential difference b/n two points in a DC ckt the Voltmeter is always Connected across them with proper polarity.

$$V = I_m (R_s + R_m)$$

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

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

Where $I_m = I_{FSD}$ = full scale deflection of the Current

R_m = internal resistance of a coil

R_s = Series resistance (or) Multiplier resistance (or) Current limiting resistance

V = full range Voltage of the instrument

Problem:-

The basic D'Arsonval movement with full scale Current of 50 µA and internal resistance is 500Ω is used as Voltmeter the find the value of multiplier resistance to measure the Voltage range of 0 to 10V ?

$R_m = 500\Omega$

$V = 10V$

$I_m = 50\mu A$

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

$$\frac{10}{50 \times 10^{-6}} - 500$$

$$= 199.5 k\Omega$$

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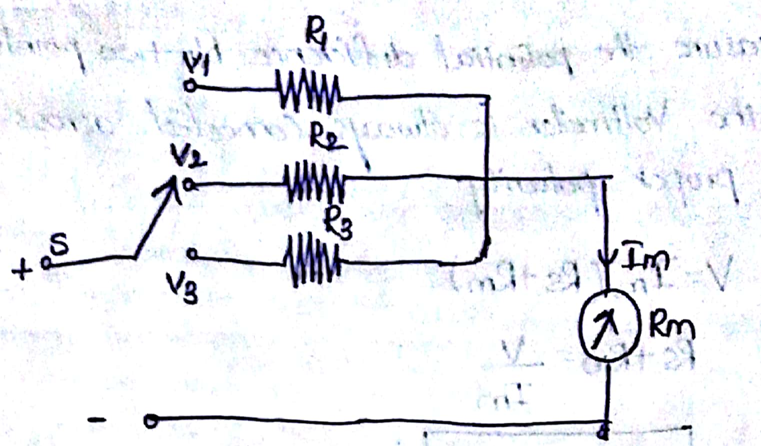
Multirange Voltmeter :—



→ The DC voltmeter is converted into multirange voltmeter by using number of multipliers and a selector switch as shown in fig.

→ Let R_1, R_2, R_3 are multipliers that gives voltage ranges V_1, V_2, V_3

→ The Multiposition switch is used to select the multiplier for required voltage range.

for $V_1 > V_2 > V_3$ then the multipliers $R_1 > R_2 > R_3$ and the multiplier resistors are given by $V_1 = I_m(R_1 + R_m)$

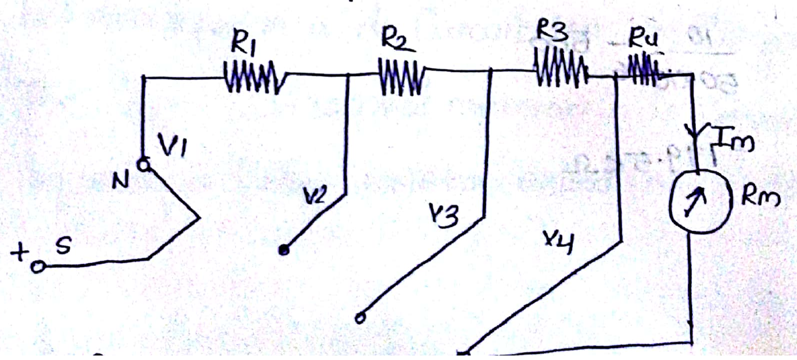
$$R_1 = \frac{V_1}{I_m} - R_m$$

Similarly $R_2 = \frac{V_2}{I_m} - R_m$

$$R_3 = \frac{V_3}{I_m} - R_m$$

→ These voltmeter requires high precision values of multiplier resistance, which increases the cost

practical multistage Voltmeter:—



→ In which the multipliers are Connected in series string and the selectorswitch selects the appropriate amount of resistance for the required Voltage.

→ When the switch is at position 4 then the multiplier resistance is R_4.

→ When switch is at position 1 then the multiplier resistance is $(R_1+R_2+R_4+R_3)$

$\therefore V_1 > V_2 > V_3 > V_4$

→ The low range multiplier R_4 is a precision value resistor hence R_4 is specially manufactured to meet the ckt requirments and remaining all are standard Values.

The multiplier resistor are calculated by using

Case 4:- $R_4 = \frac{V_4}{I_m} - R_m$

Case 3:- $R_3 + R_4 = \frac{V_3}{I_m} - R_m$

Case 2:- $R_2 + R_3 + R_4 = \frac{V_2}{I_m} - R_m$

Case 1:- $R_1 + R_2 + R_3 + R_4 = \frac{V_1}{I_m} - R_m$

Problem:-

→ A PMMC instrument with a fullscale deflection current of ~~100~~ $100\mu A$ and internal resistance of $2k\Omega$ is available it is Converted into (0-5V), (0-10V), (0-25V), (0-50V) multirange Voltmeter by using multiplier resistances at each stages then calculate the Values of individual resistance

$I_m = 100\mu A$

$R_m = 2k\Omega$

$V_1 = 50V$

$V_1 > V_2 > V_3 > V_4$

$V_1 = 50$

$V_2 = 25$

$V_3 = 10$

$V_4 = 5$

$R_4 = \frac{V_4}{I_m} - R_m$

$\frac{5}{100\times10^{-6}} - 2\times10^3 = 48k\Omega$

$R_3 + R_4 = \frac{V_3}{I_m} - R_m$

$R_3 = \frac{10}{100\times10^{-6}} - 2\times10^3 - 48\times10^3$

$= 50k\Omega$

$$R_2+R_3+R_4=\frac{V_2}{I_m}-R_m$$

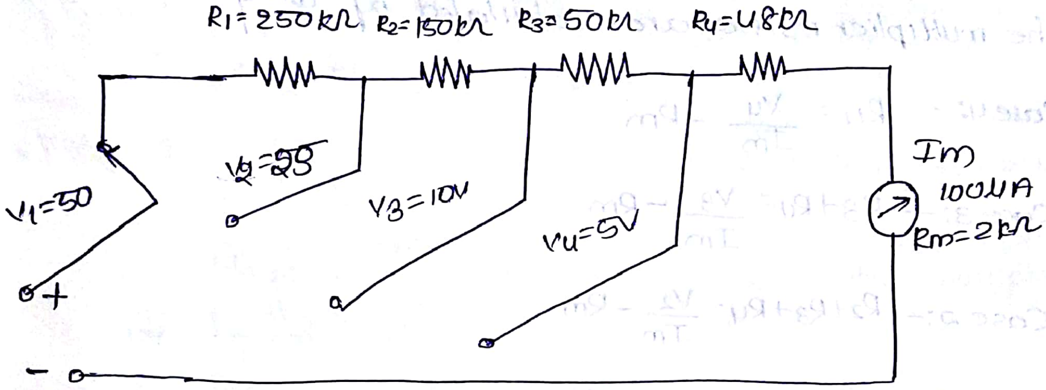
$$R_2=\frac{25}{100\times10^{-6}}-2\times10^{3}-48\times10^{3}$$

$$=150k\Omega$$

$$R_1+R_2+R_3+R_4=\frac{V_1}{I_m}-R_m$$

$$\frac{50}{100\times10^{-6}}-2\times10^{3}-48\times10^{3}-150\times10^{3}$$

$$=250k\Omega$$



→ A Basic D'Arsonval movement with a fullscale deflection current of 50µA and Internal resistance of 1kΩ is available and it is converted into (0 to 1V) (0-5V) (0-25V) (0-50V) multirange voltmeter by using multiplier resistance calculate the values of individual resistance.

$I_m=50\mu A$

$R_m=1k\Omega$

$$R_4=\frac{V_4}{I_m}-R_m$$

$$\frac{1}{50\times10^{-6}}-1\times10^{3}=19\,k\Omega$$

$$R_3=\frac{5}{50\times10^{-6}}-1\times10^{3}-19\times10^{3}=80k\Omega$$

$$R_2=\frac{25}{50\times10^{-6}}-1\times10^{3}-19\times10^{3}-80\times10^{3}=400k\Omega$$

$$R_1=\frac{50}{50\times10^{-6}}-1\times10^{3}-19\times10^{3}-80\times10^{3}-400\times10^{3}=500k\Omega$$

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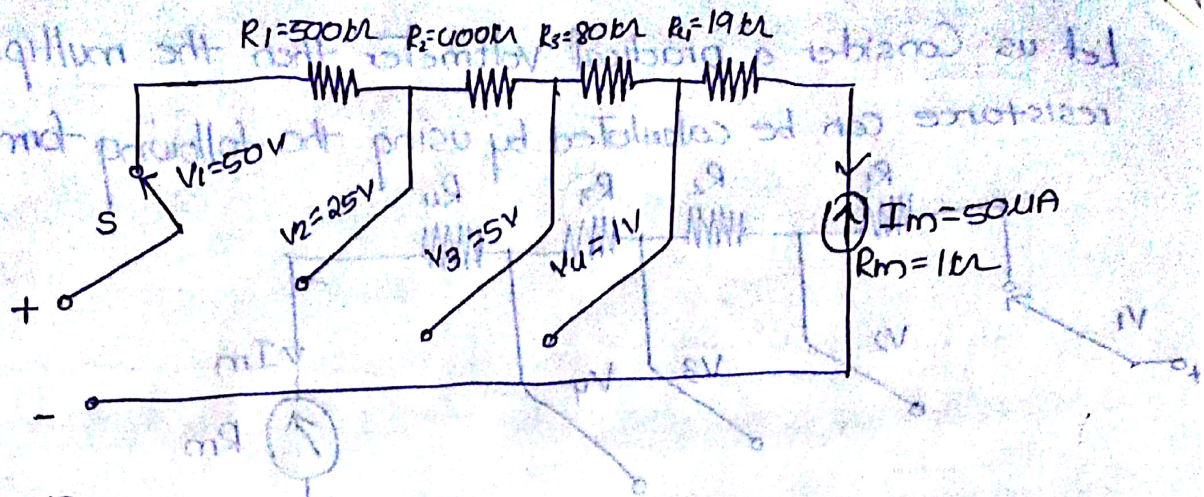
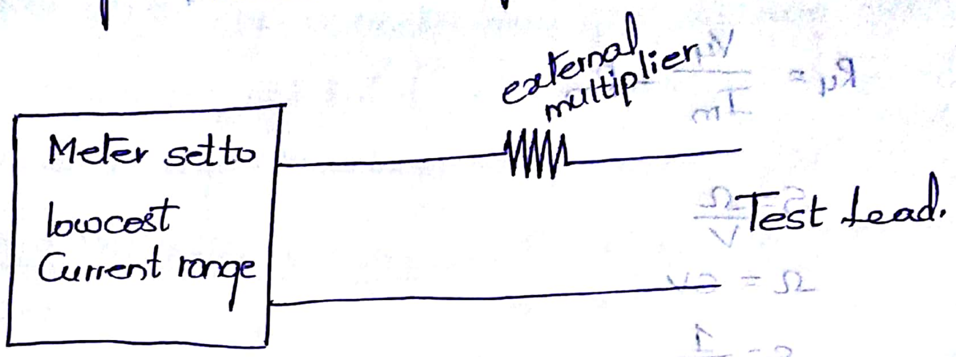


Extending of Voltmeter Range:—



The range of a Voltmeter can be extended to measure high Voltages by using a high Voltage probe or by using an external multiplier as shown in fig.

The range of multiplier can be extended but can't be lower

Sensitivity of a Voltmeter:—

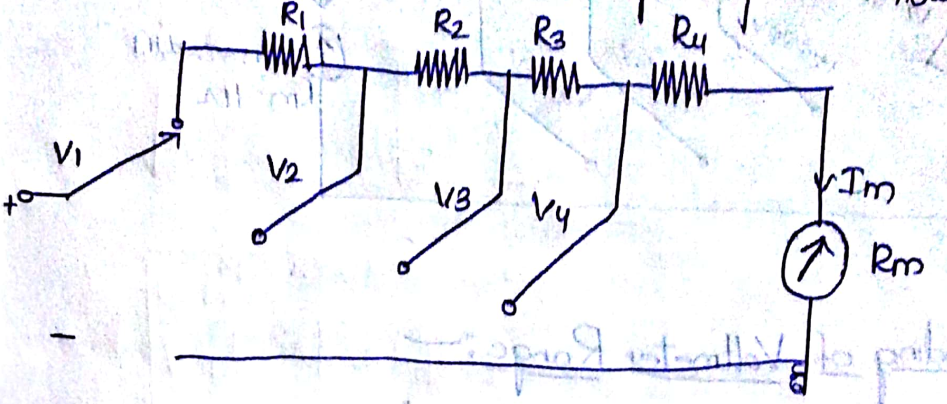
It is defined as the ratio of total Ckt resistance to Voltage range

$$S = \frac{R_t}{V} = \frac{1}{V/R_t} = \frac{1}{I_m} = \frac{1}{I_{fsD}}$$

Sensitivity is nothing but the reciprocal of fullscale deflection Current of basic meter.

Sensitivity is used in calculating the resistance of multiplier in Dc Voltmeter.

Let us Consider a practical Voltmeter then the multiplier resistance can be calculated by using the following formula



$$R_4 = \frac{V_4}{I_m} - R_m$$

$$S = \frac{\Omega}{V}$$

$$\Omega = SV$$

$$S = \frac{1}{I_m}$$

$$R_4 = SV_4 - R_m$$

$$R_3 + R_4 = SV_3 - R_m$$

$$R_2 + R_3 + R_4 = SV_2 - R_m$$

$$R_1 + R_2 + R_3 + R_4 = SV_1 - R_m$$

Problem —

→ A PMMC Instrument with a sensitivity of $10k\Omega/V$ and internal resistance is 1000Ω and it is to be Converted into (0-5V) (0-10V) (0-25V) (0-50V) multirange Voltmeter by using series Connected resistance. Calculate the Value of individual resistance ?

$$R_m = 1000\Omega$$

$$S = 10k\Omega/V$$

$$R_4 = SV_4 - R_m$$

$$= 10 \times 10^3 \times 5 - 1000$$

$$= 49k$$

$$R_3 = 10 \times 10^3 \times 10 - 1000 - 49 \times 10^3$$

$$R_3 = 50k$$

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$$R_2 = 10\times10^3 - 5 - 1000 - 49\times10^3 - 50\times10^3$$
$$= 150\,k\Omega$$

$$R_1 = 10\times10^3 - 5 - 10^3 - 49\times10^3 - 50\times10^3 - 150\times10^3$$
$$= 250\,k\Omega$$

Loading Effect:— While selecting a Voltmeter for a particular measurment the sensitivity rating is important if a low sensitivity Voltmeter may give accurate readings in low resistance ckt but it produce totally inaccurate resistance in high resistance ckt.

When a Voltmeter is Connected across a low resistance load:—

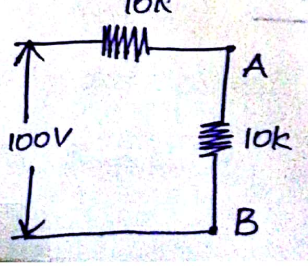
The Load resistance is lower than Voltmeter resistance. hence most of the Current passes through the load. hence Voltmeter gives the true reading.

When a Voltmeter is Connected across high resistance load:—

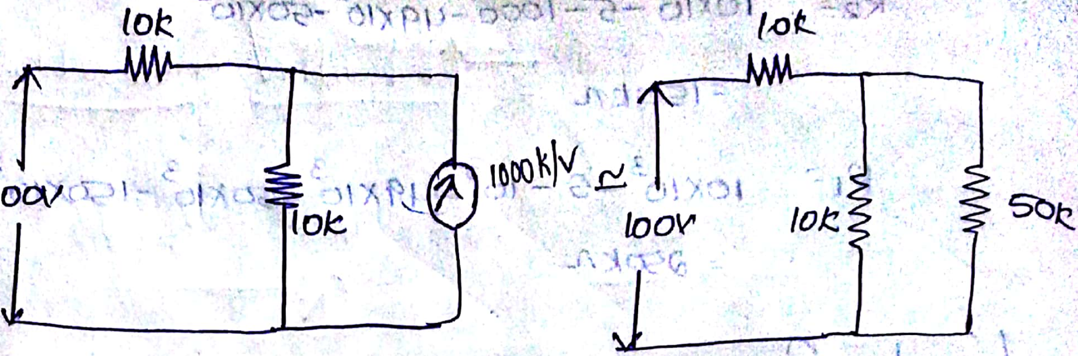
Since the Voltmeter resistance and load resistance are parallel. hence the Current will be divided into two parts The Voltage drop across the load decreases due to loading effect

The Voltmeter records the Voltage drop across the load Which is lower than the true reading. Thus with a low Sensitivity Voltmeter is Connected in high resistance ckt it gives lower reading than true reading. This is called loading effect. The loading effect Can be minimize by using high Sensitivity Voltmeter which has high resistance.

Ex:—



$$V_{AB} = 100 \times \frac{10k}{20k} = 50V$$



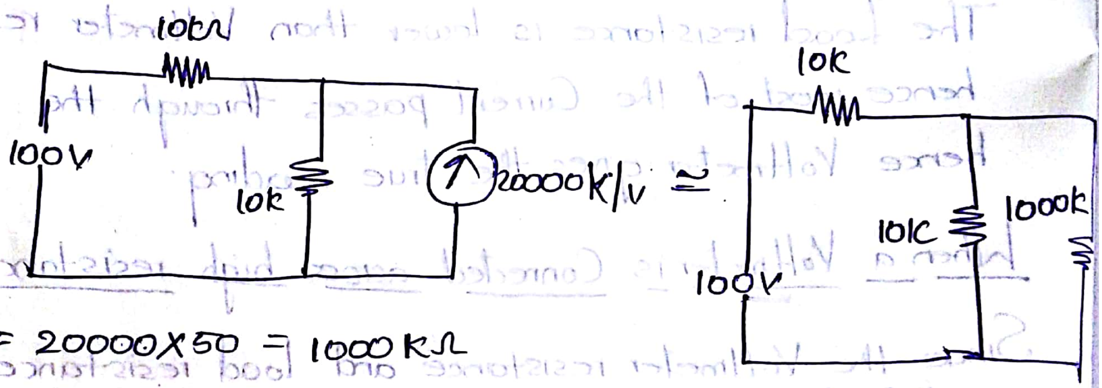
$$R_t = 1000 \times 50 = 50k\Omega$$

$$R_{eq} = 50k \parallel 10k$$

$$\frac{50 \times 10}{50+10} = 8.33k\Omega$$

$$V_{AB} = \frac{8.33}{8.33+10k} \times 100$$

$$= 45.44V$$



$$R_t = 20000 \times 50 = 1000k\Omega$$

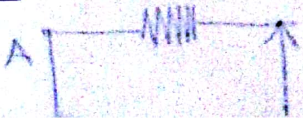
$$R_{eq} = 1000 \parallel 10k$$

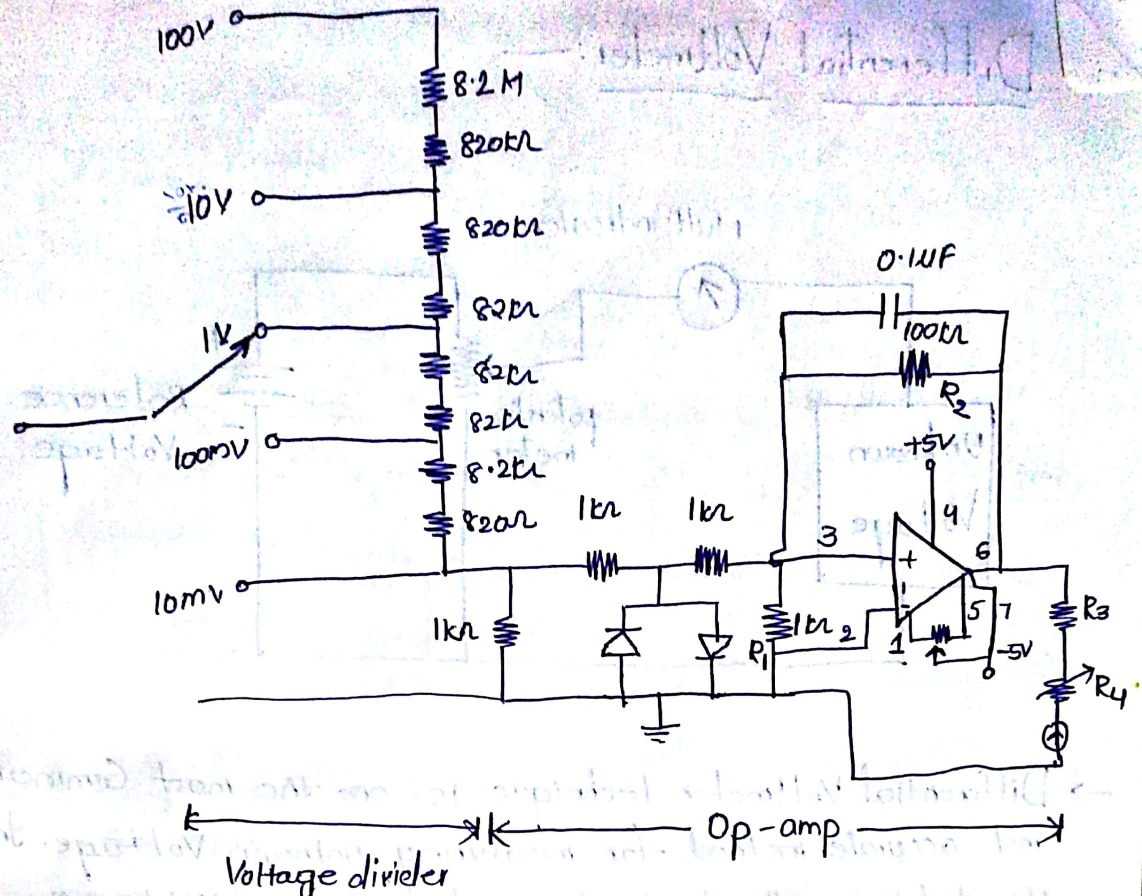
$$\frac{1000 \times 10}{1000+10} = 9.99k$$

$$V_{AB} = \frac{9.99}{9.99+10} = 49.7V$$

from this we Conclude that high Sensitivity Voltmeter gives the accurate reading.

Solid State Voltmeter:—





→ This diagram shows an electronic-Voltmeter by using direct Coupled high gain op-amp.

→ The Resistor R_2 is Connected b/n the Terminals pin 2 and pin 6 Which provides a Negative feedback

→ The gain of op-amp is adjusted to any lowered Value by using the Resistors R_1 and R_2.

→ The gain of Non inverting op-amp is given by

$$1 + \frac{R_2}{R_1}$$

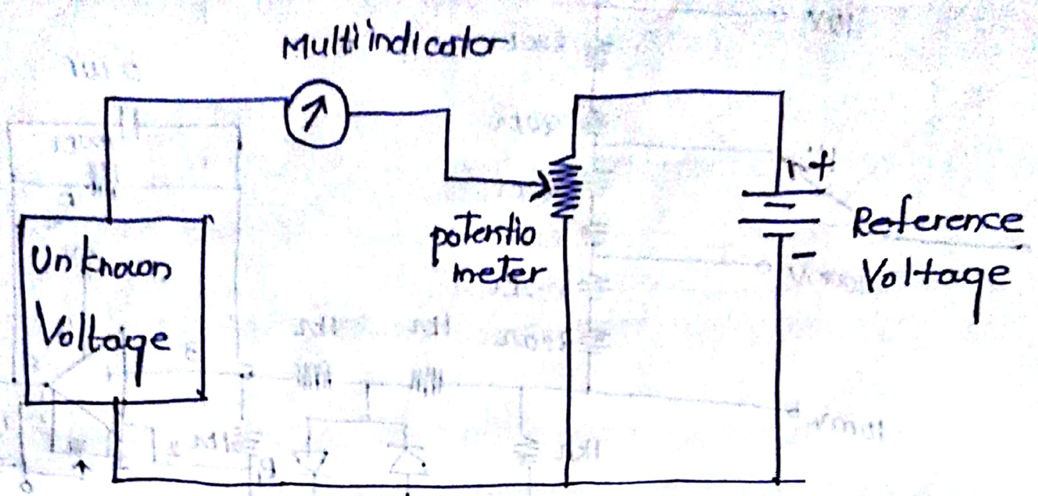
→ The 0.1uF capacitor across R_2 is for stablity unstray pickups

→ The two diodes are used for IC protection.

→ Under Normal Conditions ~~they~~ the diodes are in OFF position as the Max Voltage across them is 100mA. If it exceeds (more than 100mV) Then any one of the diode is Conducted based on the polarity and protects the IC.

→ By adjusting the Resistor R_4 We get fullscale deflection Current of the meter

Differential Voltmeter:—



→ Differential Voltmeter technique is one the most Common and accurate method for measuring unknown Voltage. In this technique null indicator is used to measure voltage difference b/n Unknown Voltage and known Voltage.

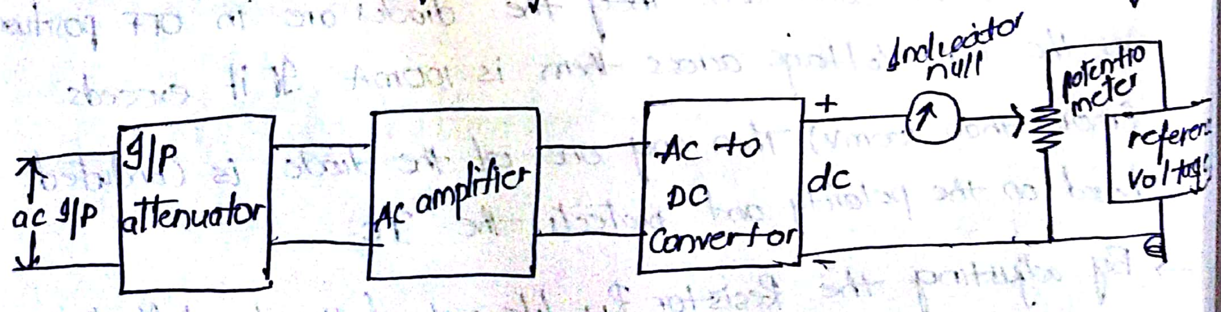
→ The potentiometer is Vary until the Voltage across the potentiometer is equals to Unknown Voltage. which is indicated by null detector.

→ Under Null Condition the meter shows zero value in general the reference Source is one word 1V be standard source.

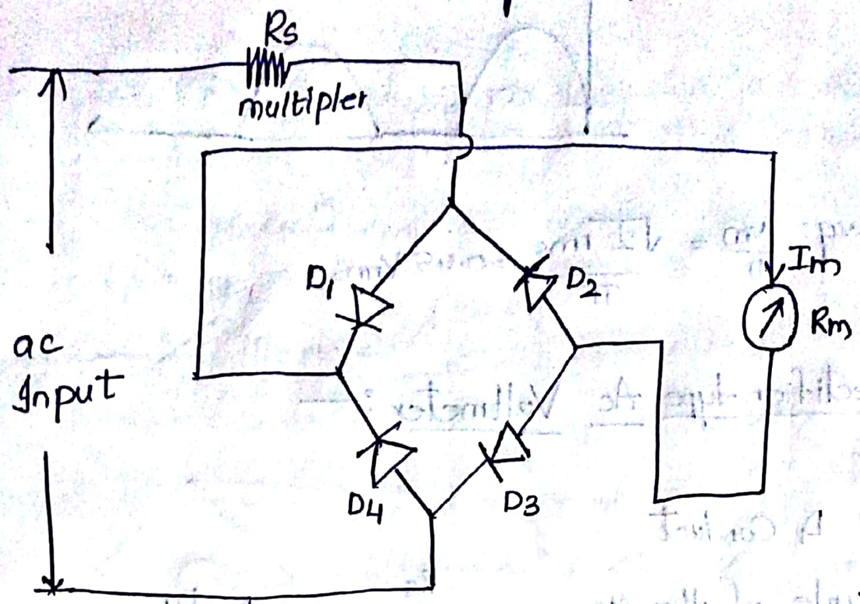
→ To detect the Small difference the meter must be Sensitive.

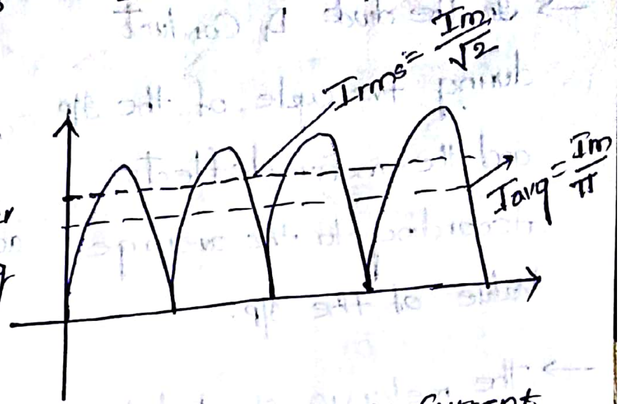
→ It is not require to calibrate the meter because it shows only zero reading. to Measure higher Voltage Voltage divider or attenuator are used to reduce the Voltage to specified I/P range.

→ To Measure the AC Voltage the AC Voltage is Converted into Unidirectional DC by using a rectifier ckt as shown in fig:



Ac Voltmeter using rectifiers:—





→ Rectifier type Ac Voltmeter uses PMMC movement along with a Rectifier arrangment as shown in fig. In which Silicon diodes are prefered because of low reverse Current and high forward Current rating.

→ The Rectifier Converts pulse rate Ac to DC and this rectifier output can be given to the DArsonval movement.

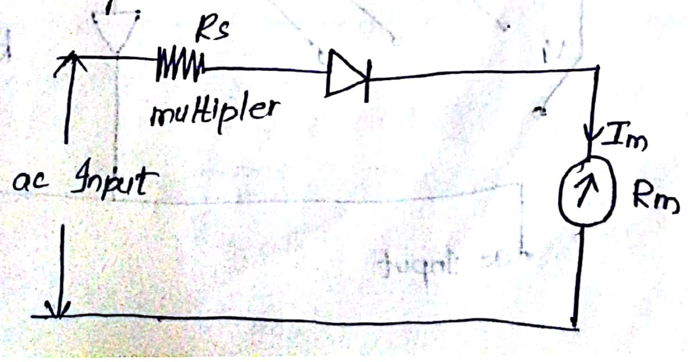
→ During +ve half cycle D1 and D3 are Conducted and -ve half cycle D2 and D4 are Conducted

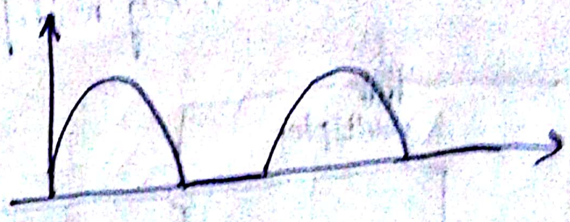
→ Because of inteia the meter will indicate a Study Value based on average Value of the I/P.

$$V_{avg} = \frac{2V_m}{\pi} = \frac{2\sqrt{2}}{\pi} V_{rms} = 0.9 V_{rms}$$

Thus the meter Indicate 90% of Rms Value of the I/P Voltage

Ac Voltmeter using Half Wave Rectifier:—

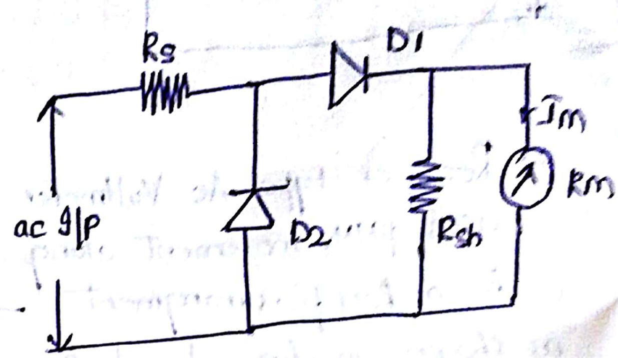




$$V_{avg} = \frac{V_m}{\pi} = \frac{\sqrt{2}\, V_{rms}}{\pi} = 0.45\, V_{rms}$$

General rectifier type Ac Voltmeter :—

→ The diode D_1 Conduct during +ve cycle of the i/p and the meter deflects. According to the average Value of the i/p.

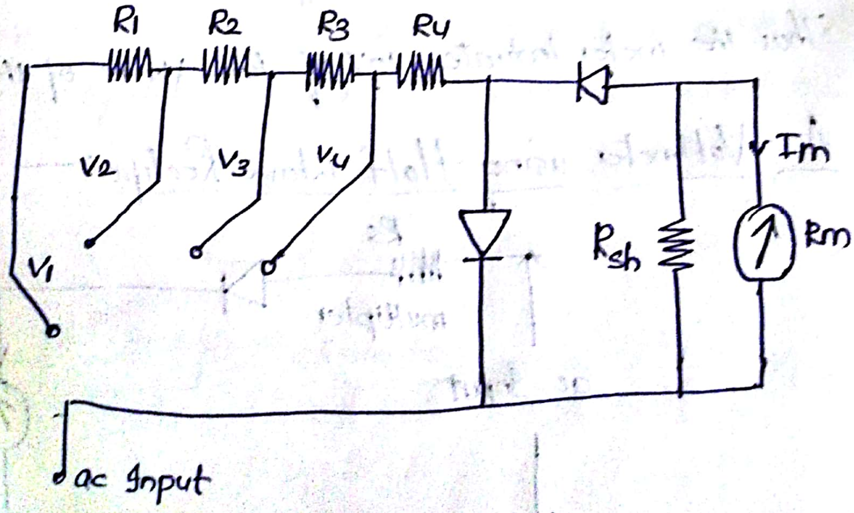


→ The meter is shunted by a resistor Rsh inorder to draw more Current through the diode D_1. So the operating point is moved to linear postion of the diode characteristics.

→ for –ve half cycle the diode D_2 is "ON"

→ It bypass the meter movement. hence the meter deflections are directly propotional to average Value of halfwave rectifier output.

Multirange Ac Voltmeter :—

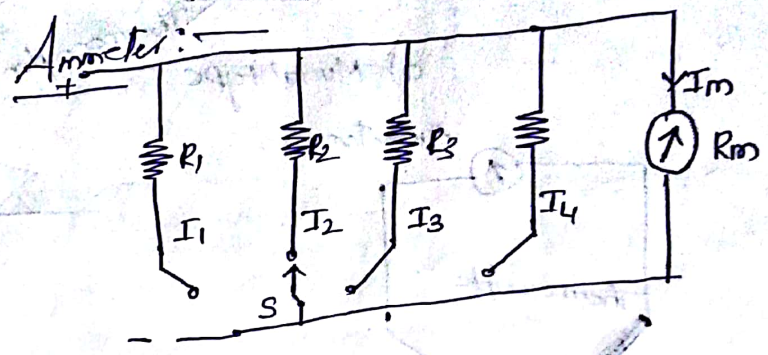


→ The circuit is used to measure AC Voltages for different ranges

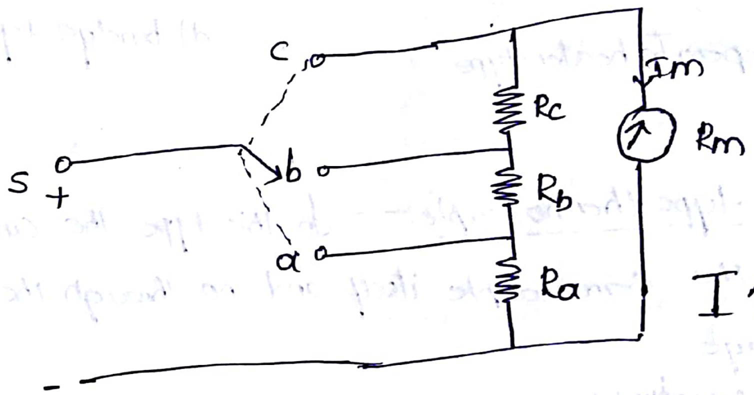
→ Let R_1, R_2, R_3 and R_4 are connected in a chain of multipliers for different ranges V_1, V_2, V_3 & V_4 respectively.

→ The Meter movement is shunted by a resistor to improve rectifier operation.

→ ~~Arc~~ Multirange Ammeter:—



Aryton shunt Ammeter (or) Universal shunt Ammeter :—



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~~If the~~

RF Ammeter (or) Thermocouple Instrument:—

→ The Combinational thermo couple and PMMC movement Can be used to measure Ac Voltages and Currents

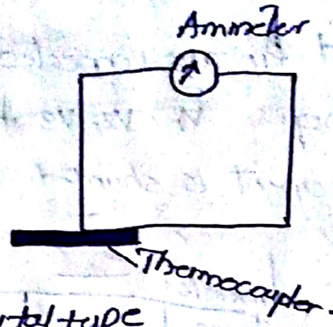
→ Thermocouple is a junction of two dissimilar metals and the Contact potential is a function of junction temperature.

→ The heater rises the temperature of the thermocouple and produce an output Voltage which is propotional to power deliver to the heater.

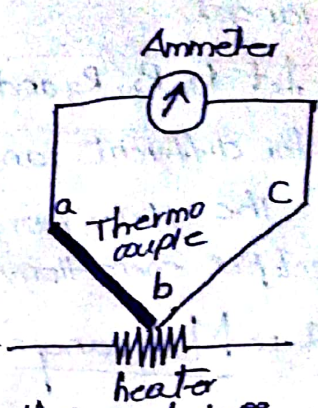
$$V_o \propto \frac{E_{rms}^2}{R_{heater}}$$

$$V_o = KE_{rms}^2$$

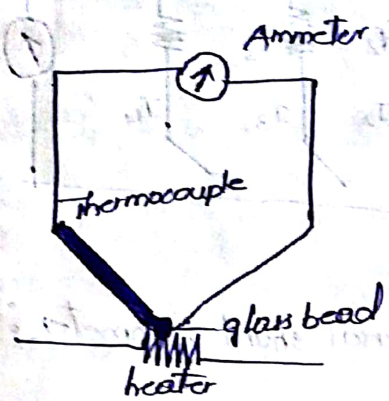
Types of Thermocouple :—



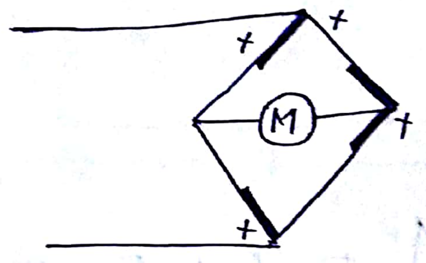
a) Mutual type



b) Contact type



c) Seperate heater type



d) bridge type

<u>Mutual type thermocouple</u>:— In this type the current flows through the thermocouple itself and no through the heater

<u>advantage</u>:-
→ good sensitivity

<u>disadvantage</u>:-
→ The ~~Mheater~~ movement is shunted by the thermocouple.

<u>Contact type</u>:—

In this type there are seperate thermocouple leads which Conduct away the heat from heater wire

<u>advantage</u>:-
No shunting effect

<u>disadvantage</u>:-
Lower Sensitivity than Mutual type.

<u>Seperate heater type thermometer</u>:—

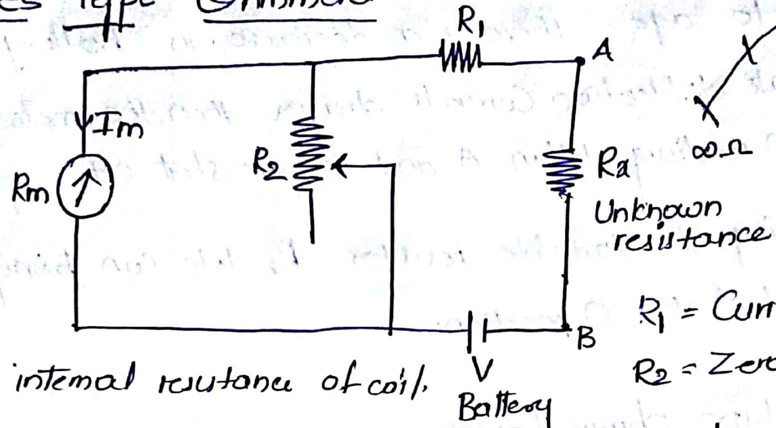
In this type thermocouple is ~~held Near~~ held near the heater but insulator from it by a glass bead.

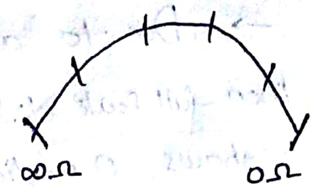
This makes the instrument Slugish and less Sensitive.
to avoid heat loss from radiation a thermocouple arrangment is placed in vaccum.

Bridge type:—

This is one type of mutual thermocouple
This device having good Sensitivity
This instrument avoids the shunting effect.

Series Type Ohmmeter :—





RM = internal resistance of coil.
R_1 = Current limiting
R_2 = Zero adjustable resistor

→ The Series type ohmmeter Consists of D'Arsonval movement connected in series with multiplier resistance 'R_1' and the battery 'V'.

→ The Unknown resistance 'Rx' is connected in series with the basic meter as shown in fig.

→ The deflection of the meter depends on the magnitude of Unknown resistance 'Rx'.

The calibration of series type of ohmmeter is as follows

i) $R_x = 0$ (A & B short ckt)

ii) Max current flows through the meter.

iii) The resistor R_2 is adjusted to get the full scale deflection current through the meter.

Then the position of pointer is marked as One on the scale.

ii) $R_2 = \infty$ (A & B are open ckt)

The current flows through the meter is Zero hence the position of pointer is marked as ∞Ω on the scale

iii) half Scale position resistance (R_h):—

It is the Value of Rx at which the meter gives half off the fullscale deflection Current.

$$R_h = (R_m \| R_2) + R_1$$

$$R_1 + \left(\frac{R_m R_2}{R_m + R_2}\right)$$

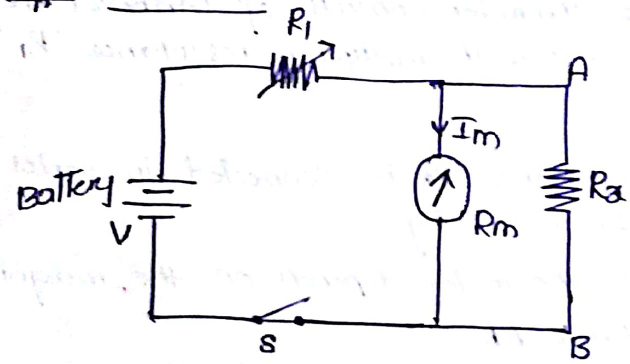
→ The intermediate readings can be found by using non value of R_x.

→ Since current is inversely propotional to resistance and meter reading is (∞ to 0Ω

→ Due to age, there is a decrease in battery voltage then full scale deflection currents draws then the meter doesn't shows 0 reading when A and B are short ckt.

by varying the variable resistor R_2 we can bring the pointer back to 0 position.

Shunt type ohmmeter :—



→ The shunt type ohmmeter consists of d'Arsonaval movement connected in series with multiplier resistance and battery

→ The unknown resistor R_x is connected across the basic meter as shown in fig.

→ The current flows through the meter the magnitude of unknown resistance

→ The switch S is provided to remove the battery when the instrument is not is used

→ The calibration of shunt type ohmmeter is as follows

(i) unknown Resistance: $R_x = 0$ (A & B short ckt)

No current flows the meter. then the pointer position is marked an '0' volts on the scale (ii) $R_x = \infty$ (A & B open ckt)

Scanned by CamScanner

→ The entire Current flows through the meter by Varying resistor R_1 to get the full scale deflection current of the meter. Then the pointer position marked as $\infty\Omega$

iii) Half scale position resistance R_h

→ It is the value of R_2 at which the current through the meter is half of the full scale deflection Current of the meter

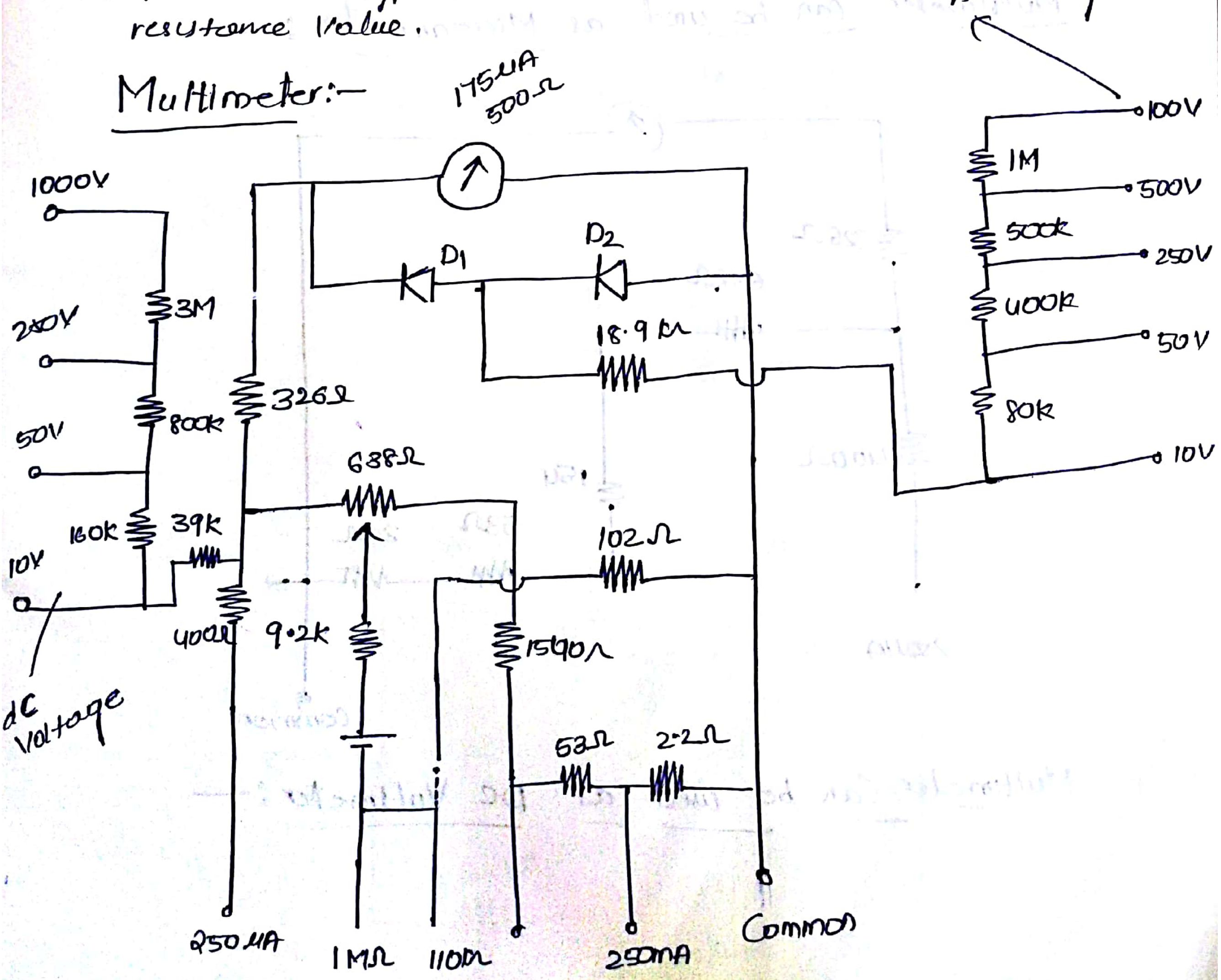
→ The intermediate marking are made by Connecting different known Values

→ Due to time and age there is a decreasing battery Voltage. due to this full scale deflection Current decreases. hence the meter doesn't show full scale reading. When the terminals A and B are opened

→ Then by Varying the resistor R_1 It is possible to bring the pointer back to full scale deflection Current of the meter

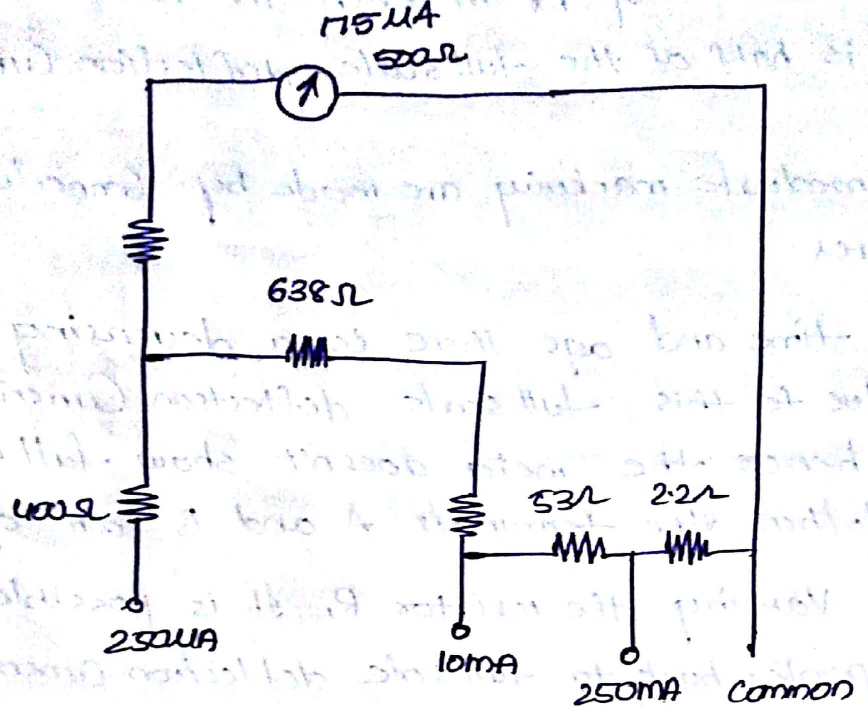
→ The shunt type ohmmeter has used to measure low resistance Value.

Multimeter:—

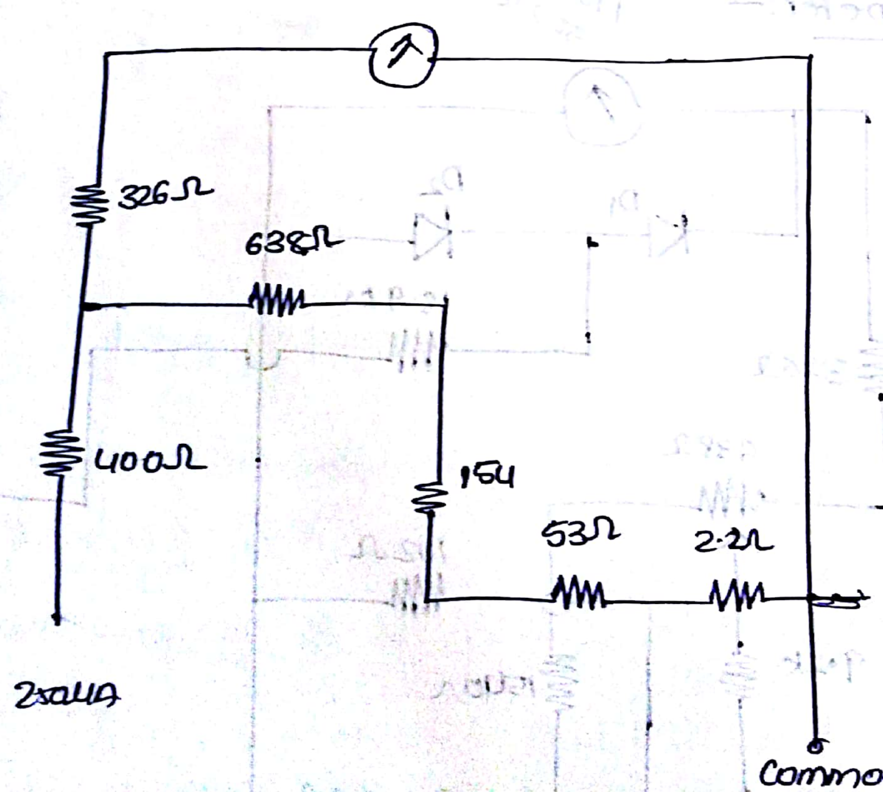


The Multimeter consists of DC Voltmeter from AC Voltmeter DC milli Ammeter

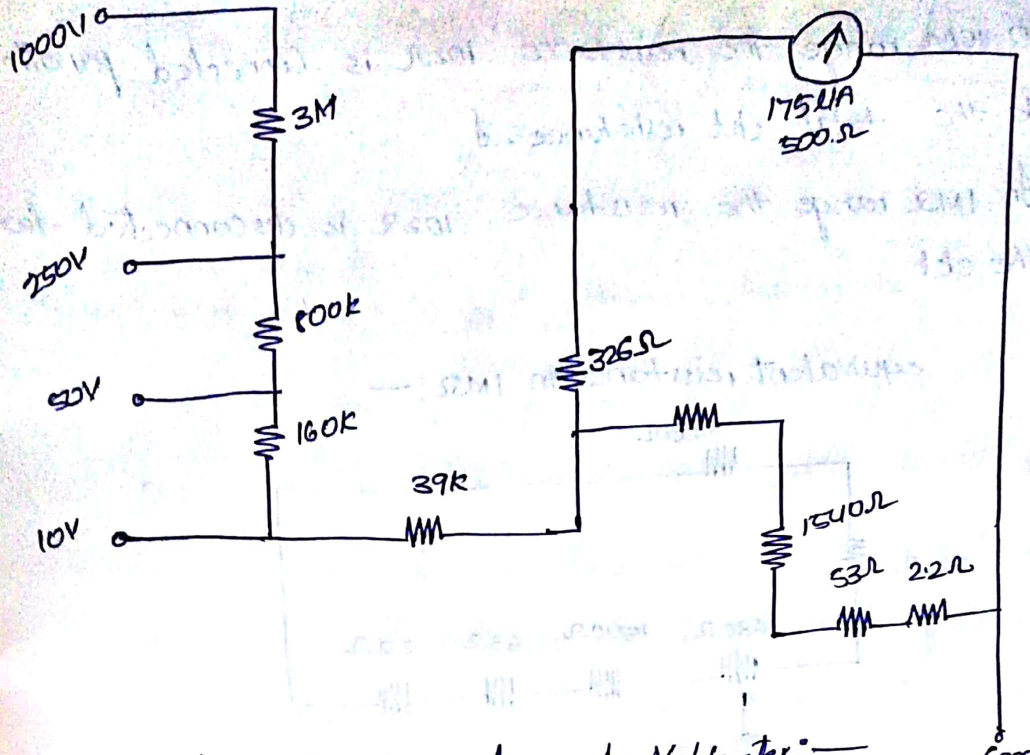
The Multimeter can be used as DC Millimeter as shown in fig



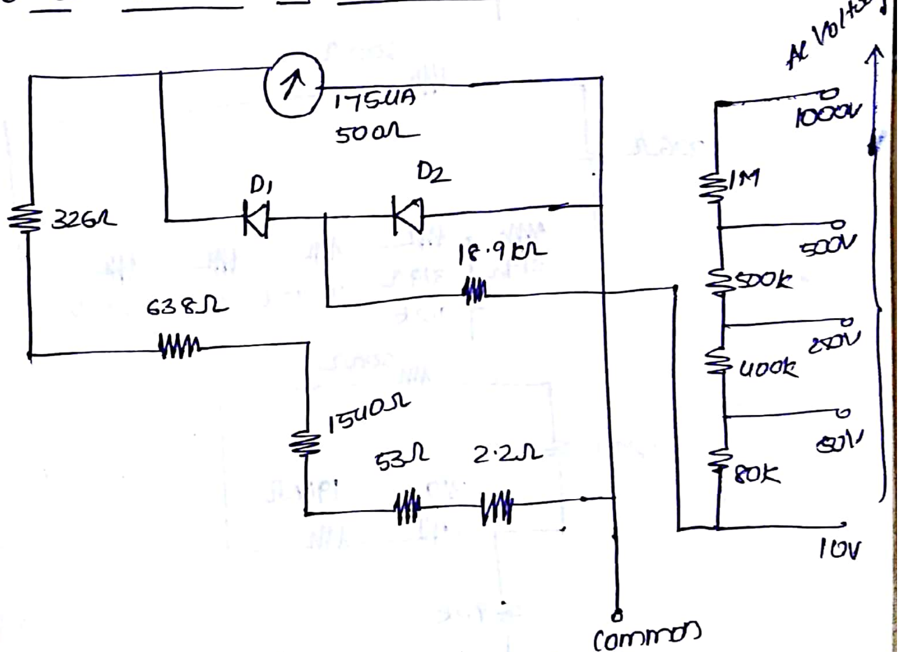
Multimeter can be used as Microammeter :—



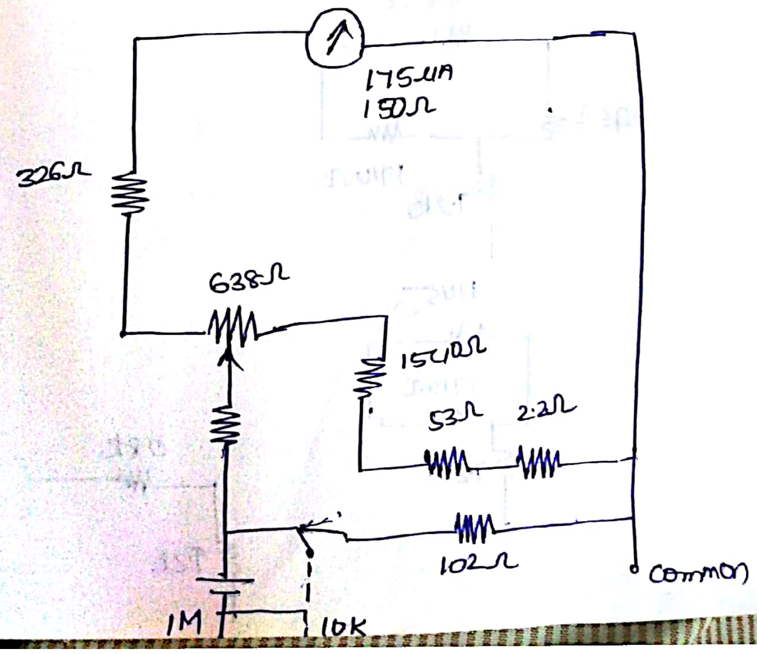
Multimeter can be used as DC Voltmeter :—



Multimeter Can be used as Ac Voltmeter:—



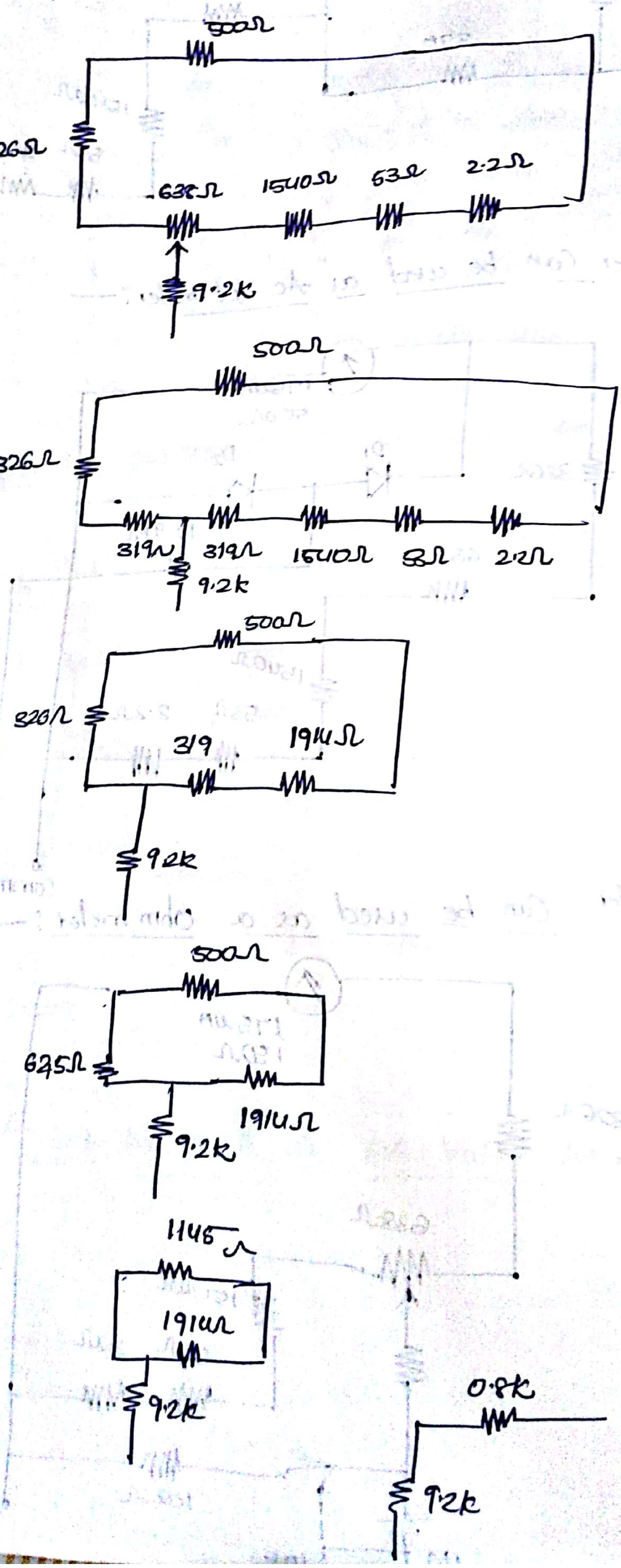
Multimeter Can be used as a Ohm meter :—



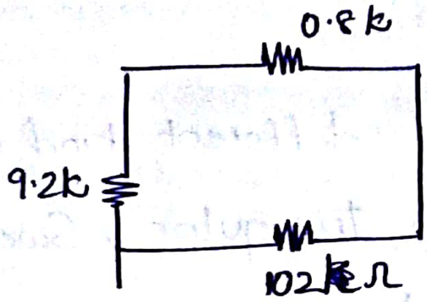
→ In 10kΩ range the resistance 102Ω is connected parallel to the total ckt resistance.

→ In 1MΩ range the resistance 102Ω is disconnected from the ckt

equivalent resistance on 1MΩ:—



On the 1MΩ the half scale deflection 10kΩ



Req = 10aΩ

on the 10kΩ range the half scale deflation is 100Ω

The Range of ohmmeter Can be change by Connecting a suitable shunt resistance to the Circuit.