ELECTRONIC MEASURING INSTRUMENT

Unit - I

Basics Of Measurments

Measurment

It is an act of comparison of unknown quantity with a known predefined accurate standard quantity

Application of Measurments

1) For recording or observing the output of a process.
2) To control a process / operation
3) For analysing Purpose.

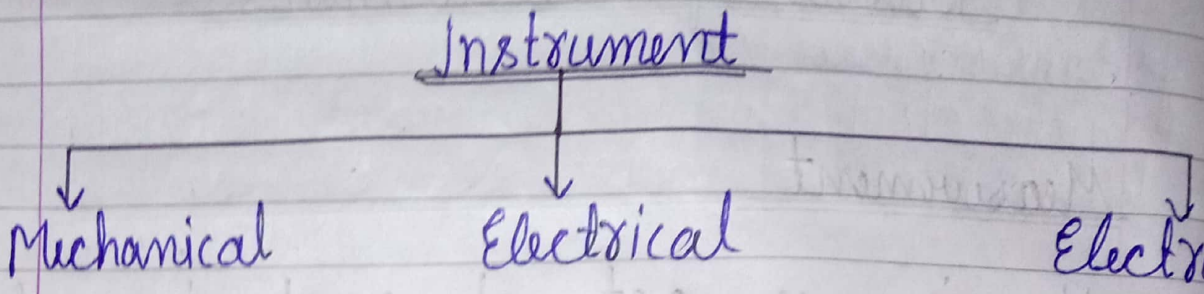
Methods of Measurments

It can be broadly classified into two categories

i) **Direct Measurment**
It includes comparison with standard quantities finding the unknown magnitude
E.g.: Simple weigh balance. Potentiometer

ii) **Indirect Measurment**
It includes instruments for measuring unknown magnitude.
E.g.: Voltmeter, Ammeter.

Types of Instruments



The ammeter, Voltmeter, watmeter are the examples electrical Instrument The electronic instrument has quick response time. The instrument provides the quick responses as compared to the electrical and mechanical instrument.
The ammeter, Voltmeter, ameter measures the current voltmeter measures the voltage.

Specifications Of Instruments:-

Accuracy

a) Accuracy as Percentage of full scale reading In case of instrument having scale the accuracy can be expressed as percentage of full scale reading.

b) Accuracy of Percentage of true value of quantity being measured

$$\frac{\text{Measured Value}}{\text{True Value}} \times 100$$

Point Accuracy

Such accuracy is specified at only one particular point of scale. It does not give any information about accuracy at any other point of scale.

Precision

It is the measure of of consistency or Repeatability of measurments. It denotes the closeness with which individual measurments are departed or distributed about the averag of no. of measured values.

Sensitivity

It is the ratio of the change in the input of an instrument to a change in the value of the quantity to be measured.

$$\text{Sensitivity} = \frac{\Delta v_o}{\Delta v_i}$$

Resolution

It is the smallest measurable input change. The resolution of an instrument is also referred as descrimination of the instrument.

Range

The minimum and maximum values of a quantity for which an instrument is designed to measure is called its range

Error in Measurments

1) Systematic Error

These types of systematic errors are generally categorised into three types

- Observational Error
- Enviromental Error
- Instrumental Error

- **Observational Error**
The observation error may occur due to the fault study of the instrument reading

- **Enviromental Error**
It is happen due to the outside situation of the measuring instrument

Instrumental Error
It is happen due to ~~some~~ inherent limitation of Devices, abuse of apparatus Effect of loading.

2) Gross Errors

It can be defined as physical errors in analysis apparatus or calculating and recording measurment outcomes.

3) Random Errors

This type of error is constantly there in a measurment which is occured by esentially random oscillations in the apparatus measurment analysis.

Absolute Error = $|V_A - V_E|$

Percentage Error(%) = $(|V_A - V_E| / V_E) \times 100$

Relative Error = Absolute Error / Actual Value

Sources of Errors

1) Poor design
2) Poor Maintainence
3) Certain design limitations
4) Change in process parameters, irregularities upsets etc.
5) Error caused by person operating the instrument

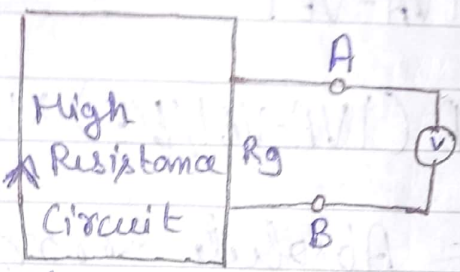
Limiting Errors

The limited deviation of the measured value from the true value is known as the limiting error. Such type of error is fixed on the instrument. The value could be atleast but never zero.

Loading Effect

Loading Effect is the degree to which a measurement impacts electrical properties of a circuit. It is a ideal measuring system

"किसी मापन प्रणाली की Input signal को ठीक प्रकार रिकॉर्ड अथवा Control ना करने की क्षमता को Loading effect कहते हैं"



Loading Effect = True Voltage - Apparent Voltage

Importance And Application of Standards and Caliberation.

Whenever a new piece of measurment equipment is manufactured it must first be caliberated to the the required standard before it is used.

There is a vast array of measurment equipment Some devices may be small, simple. Each measurment device will have its standards and tolerances The frequency of the re-caliberation will vary from

device to device.
The piece of measurment equipment will be checked and realigned to the original measurment standard.
Servicing and caliberation are vital to the main accuracy of the readings measurments

Measurment Standard

A material measure measuring instrument reference material or measuring system intended to define. Definition of the standard to be fixed and correct.

Caliberation

The goal of caliberation is to minimise any measurment uncertainly by ensuring the accuray of test equipment. Caliberation quantities and controls errors or uncertanities measurment processes to an acceptable level.

ELECTRONIC MEASURING INSTRUMENT

Unit-II

Voltage, Current and Resistance Measurment

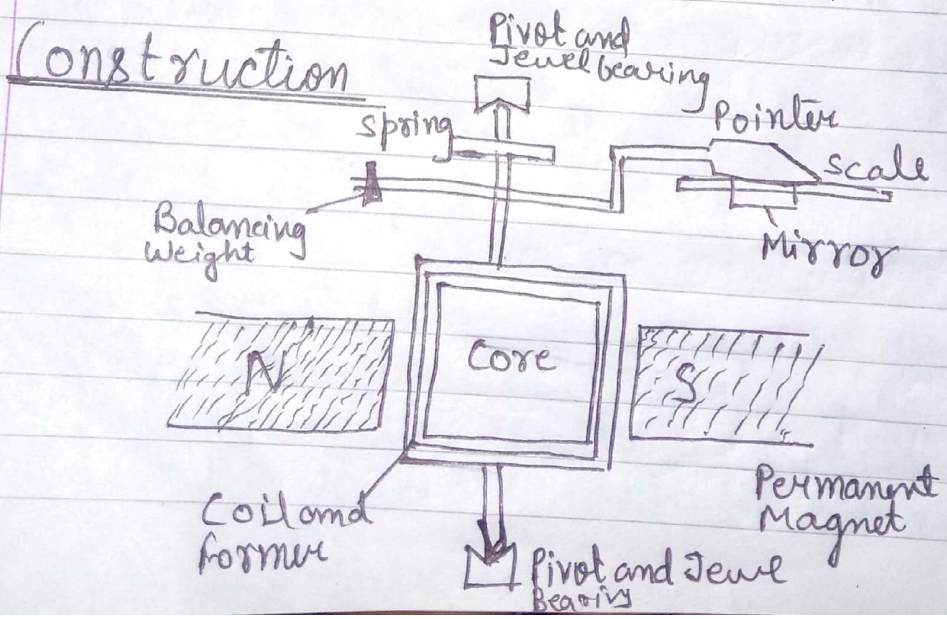
Principles of Operation and Construction of Permanent Magnet Moving coil Galvanometer (PMMC) Instrument.

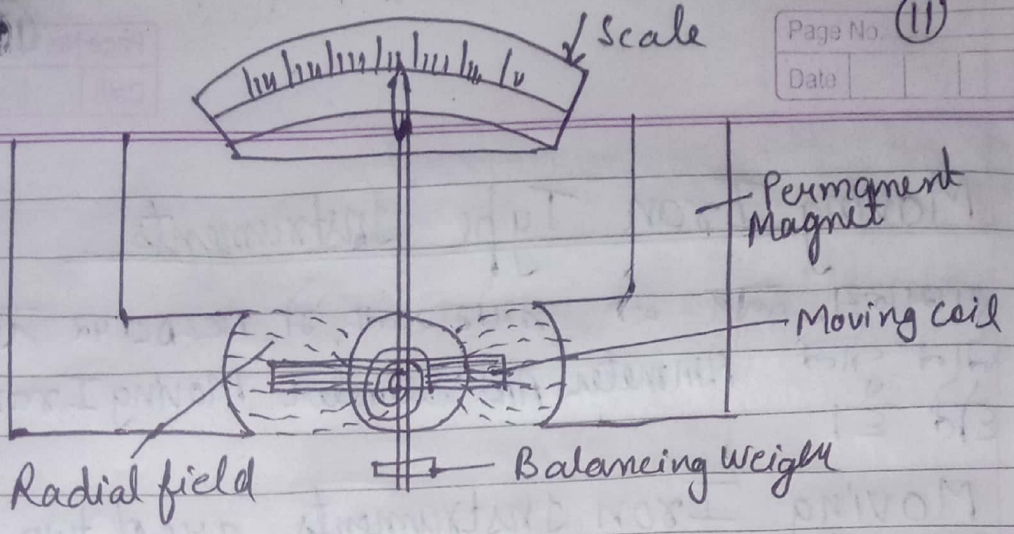
Principle of Working.

When a current carrying conductor is placed in a magnetic field, its expriences a force and tends to move in the direction. It is also called (d'Arsonval)

इस प्रकार के मापक यन्त्रो मे एक स्थायी चुम्बकीय क्षेत्र मे एक Pivot रहती है यह Aluminium की Bobbin पर लिपटी होती है, मापी जाने वाली धारा अथवा Voltage इस कुण्डली को प्रवाहित की जाती है स्थायी चुम्बक Alcomax अथवा Alnico के बनाये जाते है,

Construction





Moving coil Galvanometer

A coil of thin wire is mounted on an Al. Frame positioned between the poles of U shaped permanent magnet which is made up of alloys. The coil is pivoted on the jewelled bearing and thus the coil is free to rotate. The current is fed to the coil through spiral springs which are two in number. The coil which carries a current which is to be measured moves in a strong magnetic field produced by a permanent magnet and a pointer is attached to the spindle which shows the measured value.

Advantages :

- The PMMC has a high torque to weight ratio
- It produces no loses due to hysteresis.

Disadvantages

- It is very delicate and sometimes uses AC circuit with a rectifier.
- It may show an error due to loss of magnetism of permanent magnet.

Moving Iron Type Instruments

सामान्य रूप से प्रयोगशाला मे AC/DC पर प्रयुक्त किये जाने वाले Ammeter And Voltmeter Moving Iron Type होते है।

Moving Iron Instruments are of two types
- Attraction type moving iron instruments.
- Repulsion type moving iron instruments

Attraction Type Moving Iron Instruments

When a soft iron piece (vane) is placed in the M.F. of a a current carrying coil then the piece is attracted towards the center of the coil.

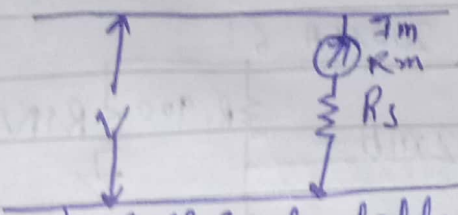
Repulsion Type Moving Iron Instruments

The basic principle of a repulsion type moving iron instruments is that the repulsive forces will act when two similarly magnetized iron pieces are placed near each other.

Measurment of d.c voltage and current.

एक Basic PMMC (d'Arsonval) Type यन्त्र के श्रेणी में प्रतिरोध connect करने पर यह Voltmeter मे परिवर्तित हो जाता है। मल्टीप्लायर के अनुसार किसी यन्त्र के श्रेणी में प्रयुक्त

किए जाने वाला प्रतिरोध है जो यन्त्र की Voltage मापन की Range बढ़ाता है, मीटर R_S का श्रेणी संयोजन उस परिपथ मे संयोजित किया जाता है।



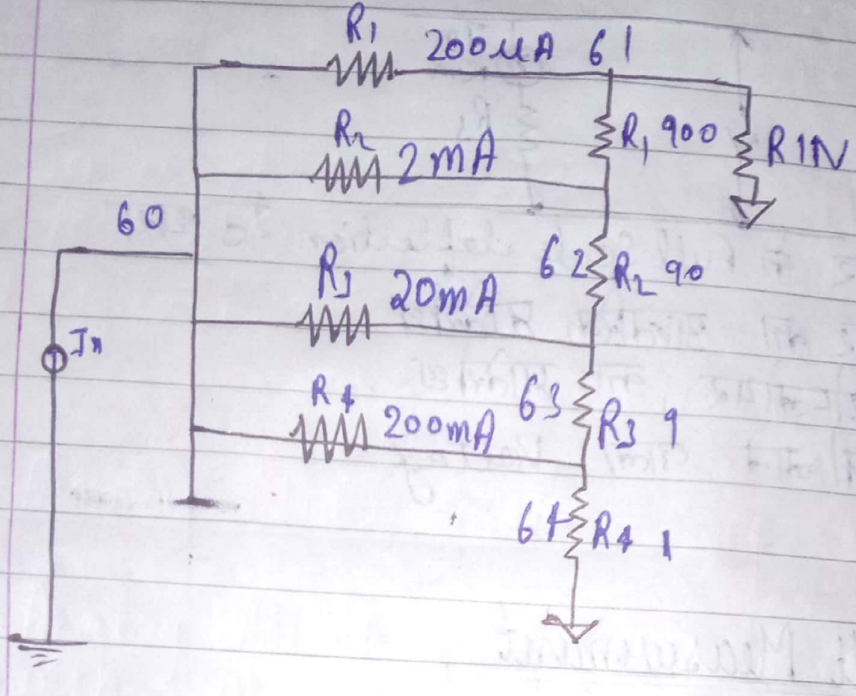
I_m = मीटर के Full Scale deflection हेतु धारा
R_m = मीटर का आन्तरिक प्रतिरोध
R_S = मल्टीप्लायर का प्रतिरोध
V = मापी जाने वाली Voltag

Mili- Volt Measurment

We can measure milivolt with some voltmeter and multimeter
Step-1
Plug red probe to +v hole
Step-2
Plug black to -v hole
Step-3
Turn the dial to milivolt. The setting should be close but not over the maximum voltage
Step-4
Turn your meter on.
Step-5
Hold the insulated handles of your probes
Touch red to +ve side of DC circuit or AC circuit and black probe to -ve
Step-6

Read the measurment.

Measurment of DC Current.



The idea is to insert an accurately known resistance R in series with a circuit to create a voltage proportional the current flow

1) A resistance big enough to get a decent size voltage level.
2) A resistance small enough to avoid significantly effecting the circuit operation.

For the 200uA range only R1 is closed The current flows through all resistors R1 4 for

$$Rs = 900 + 90 + 9 + 1$$
$$= 1K$$

The measured voltage V_{61}

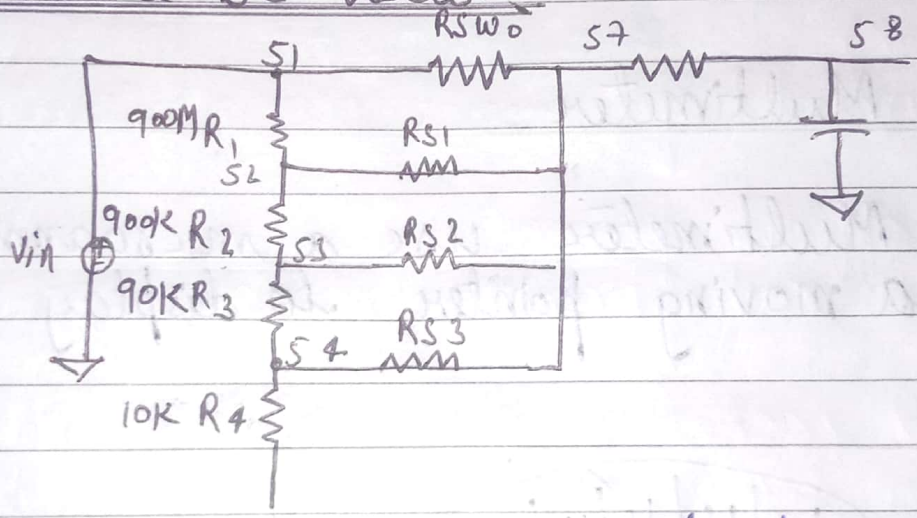
$$Rs \cdot Im$$

1K · 200μA
= 200mv

RS = 1ohm

The measured voltage at Vc+
Vm = Rs . Im
1 · 200mA
= 200mV

Measure DC Volts.



The resistance value look intuitively

R_A = 900k + 90K + 9K + 1M
R_B = 9M
A simple divider

$V_o = R_B/(R_A+R_B) = 1M/(1M+9M) = 1/10$

Resistors down
R_A = 90K + 9K + 1K = 0.1 M
R_B = 9M + 900K = 9.9M

Multimeter

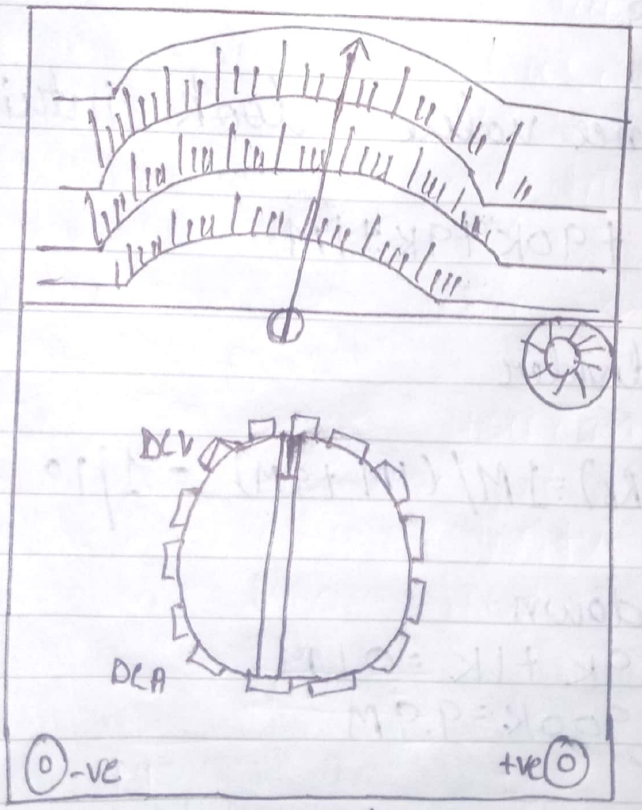
It is an electronic measuring instrument that combines several measurment function in one unit.

Types of Multimeter

1) Analog Multimeter
2) Digital Multimeter.

1) Analog Multimeter

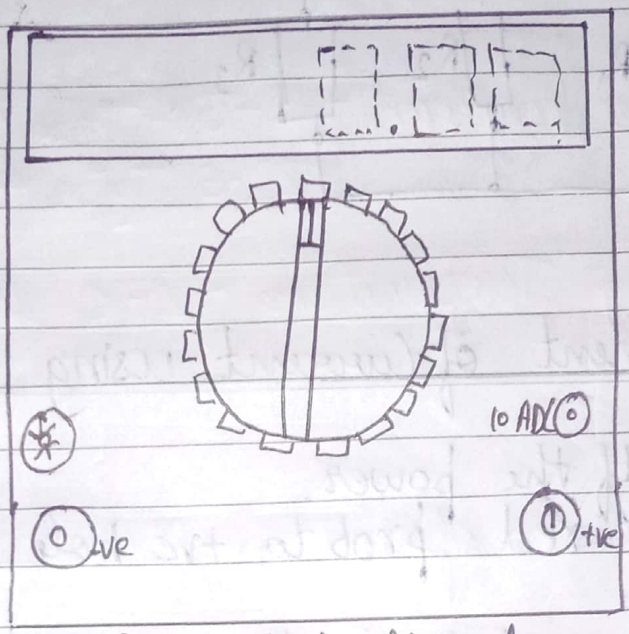
Analog Multimeter use a microammeter with a moving pointer to display reading



Analog Multimeter

2) Digital Multimeter

It has numeric display and may also show a graphical bar representing the measured value.

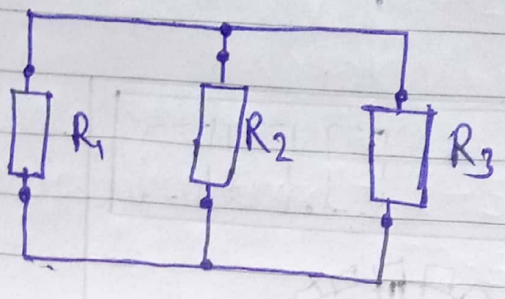


Digital Multimeter

Measurment of Voltage Using Multimeter

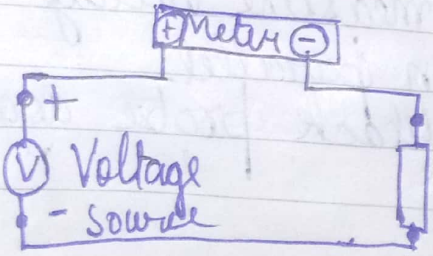
1) Power off the circuit
2) Plug the black Prob to -ve com
3) Plug red Prob to +ve hole.
4) Select AC or DC volt and pick range to required accuracy
5) A multimeter must be connected in parallel in order to measure voltage. the two test probe connect in parallel.
6) Touch the black probe against the first point.

7) Power up the equipment.
8) Touch red probe against second point of test
9) Take the reading on the display.



Measurment of Current using Multimeter

1) Turn off the power.
2) Connect red prob to +ve hole and black to -ve hole.
3) The mA socket is often marked with the maximum current. must use 10A socket
4) A multimeter must be ~~inster~~ inserted in series in circuit in order to measure current.
5) Turn the dial to meter to highest range
6) Turn on the power
7) If range is too high you can switch to lower range
8) Remember to return the +ve probe to the V socket when finished measuring current



Measurement of Resistance Using Multimeter

1) If the component is on a circuit board., turn off the power.
2) Disconect on end of the component. This may involve pulling of desoldering The resistance should be in Parallel with the component being measured.
3) Connect the probe to +ve red and -ve to black.
4) Turn the dial to lowest Ω range
5) Place a probe tip at each end of the component being measured.
6) If the display indicates 1 this means that resistance is greater that can be displayed on the range setting So must turn dial to the next highest range until a value displayed on L.C.D.

Specification of Multimeter

Specification of Analog Multimeter

1) Sensitivity on DC - 25 K ohms/volt
2) Voltage Ranges DC - 0 to 0.25, 5, 50, 500V, 0 to 2.5 0 to 125 mV, 2.5 V, 25V, 250V and 1.2kV
3) DC Current Ranges - 0 to 40 uA, 2.5mA
4) Sensitivity on AC - 2500 ohms/volts
5) AC voltage Ranges - 0-5v, 0-50V
6) AC current Ranges - 0-100mA, 0-500mA
7) Resistance Ranges - Rx1, Rx10, Rx100

8) Accuracy
9) Resistance - R x 1, R x 10 } 2-5°

R x 100, R x 1K, R x 10K } 2°

10) Batteries Required - 1-5V-Type 915
22-5 Type 412

11) Operating Temperature - 27°C for rated accuracy

Specifications of Digital Multimeter

1) Accuracy

This is the largest allowable error that you DMM occurs under specific operating condition.

2) Resolution

This is the smallest increment of change a DMM can detect and display.

3) Range

DMM range and resolution are related It provides an autorange function.

4) Display Digits

This is used to describe a DMM's resolutio

5) Display Counts

It tell you what a DMM will display before it changes to the next range.

6) The multimeter should have 'diode check featur

Applications of Multimeter

1) Testing Voltage
2) Testing Current
3) Testing Resistance
4) Test batteries
5) Test a switch.

Limitations with regard to Frequency and Input Impedance

The multimeter has to rectify the AC wave and in doing that applies some capacitors to reduce the ripple in the rectified DC voltage but if frequency is greater than the limit the sample taken is wrong becaus it takes no just the reading of one period of the almost DC rectified signal but actually takes values of the other periods if the frequency is high.

When used for measuring voltage the input input impedance of the multimeter must be very high compared to the impedance of the circuit measured

otherwise circuit operation may get changed and reading will also get inaccurate.

Lower Sensitivity meter movements are acceptable for testing in circuit where source impedance are low compared to meter impedance.