LECTURE NOTES ON

ELECTRONICS MEASUREMENT AND INSTRUMENTATION

3RD SEMESTER ETC

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CHAPTER-1

* QUALITIES OF MEASURMENT *

1. Instrument and measurment :-

1. Instrument :-
It is a device for determining values or magnitude of a quanity or variable through a given set of formulas.

2. Measurement :-
It is a process of compairing an unknown quantity with an accepted standard quantity.

1.1 Electronic measurement & instrumentation :-
It is the branch of Electronics which deals with the study of measurement and variations of different parameters of various instruments.

* Why measurement of parameters and study of variations for a particular instrument are reqaired?
The measurement of parameters and its variations for a particular instrument is required because it helps in understanding the behaviour of an instrument.

(2) Measurement system performance :-
The performance of the measurement system / instruments are divided into two categories.
1. Static characteristics.
2. Dynamic characteristics.

(3) Static characterstic of Instrument :-

1. Accuracy :- It is defined as the ability of a device or a system to respond to a true value of a measure variable under condition.

(2) Precision :-
Precision is the degree of exactness for which an instrument is design or intended to perform.

(3) Repeatability :-
The repeatability is a measuring device or a system may be defined as the closeness of an agreement among a number of consecutive measurement of the output for the same value of the input under save operating system.

(4) Reproducibility :-
Reproducibility of an instrument is the closeness of the output for the same value of input. Perfect reproducibility means that the instrument has no drift.

(5) Sensitivity :-
Sensitivity can be defined as a ratio of a change output to the change input at steady state condition.

(6) Resolution :-
Resolution the least increment value of input or output that can be detected, caused or otherwise discriminated by the measuring device.

(7) True value :-
True value is error free value of the measure variable it is given as difference between the instrument Reading and static error.

Mathematically;

True value = Obtained instrument reading - static error.

Note - % Error = $\frac{\text{Standard Reference value} - \text{Obtained Reading}}{\text{Standard Reference value}} \times 100$

DYNAMIC CHARACTERISTICS OF INSTRUMENT :-
The dynamic characteristics are those which change within a period of time that is generally very short in nature.

1. Speed of Response :-
It is the rapidity with which an instrument responds to the changes to in the measurement quanity.

2. Fidelity :-
The degree to which an instrument indicate the measure variable without dynamic error.

3. Lag :- It is retardation or delay in the response an instrument to the changes in the measurement.

* ERROR :-
The deviation or change of the value obtained from measure-ment from the desired standard value.

Error = obtained Reading / value - standard Reference value
There are three types of error. Theory are as follows.

A Systematic Error :-
A constant uniform deviation of an instrument to the systematic error. There are two types of systematic error.

(a) Static Error :-

The Static error of a measuring instrument is the numerical between the true value of quantity and its value as obtained by measurement.

(b) Dynamic Error :-

1. It is the different between true value of a quantity Changing with and value indicated by the instrument.

2. The Dynamic Erros are caused by the instrument not responding fast enough to fllow the change in the measured value.

B. RAMDOM Error :-

The cause of such error is unknown or not determin-ded in the ordinary process of making measurement.

Types of Static error :-

(I) Instrumental Error :-

Instrumental error are erros inherent in mastering instrument because of the mechanical construction friction is bearing in various moving component. It can be avoided by

(a) Selecting suitable instrument for the Particular measurement.

(b). Applying Correction factor after determining the amount of instrumental error.

(ii) Envinomental Error :-

Enviromental error are due to Conditions external external to the measuring device including condition al in the area surrounding the instrument such as effect of change in temperature, humidity or electrostatic field it can be avoided

a. Providing air conditioning.

b. Use of magnetic shields.

(iii) OBservational error :-

The erros introduced by the observer. These errors are caused by habits of observers like tilting his/her head too much while reading a "Needle-Scale Reading.

CHAPTER - 02

Indicating instrument

Introduction :-

Measuring instruments :-

Measuring instruments are classified according to both the quantity measured by the instrumen and the principle of operation.

There are three general Principles of operation :-

* Electromagnetic, which utilizes the magnetic effects of electric currents.

* Electro-thermic, which utilizes the ~~magnetic~~ heating effects. ~~currents~~.

* Electrostatic, which utilizes the forces between electrically-charged conductors.

The essential requirements of measuring instruments are :-

* It must not alter the circuit conditions.
* It must consume very small amount of power

* Electric measuring instruments and meters are used to indicate directly the value of current, voltage, power or energy.

* An electromechanical meter (input is an electrical signal results mechanical force or torque as an output) that can be connected with additional suitable components in order to act as an ammeters and a voltmeter.

* The most common anologue instrument or meter is the permanent magnet moving coil instrument and it is used for measuring a dc current or voltage of an electric circuit.

Types of Forces / Torque acting in measuring instrument :-

(1) DEFLECTING TORQUE / FORCE :-

* The deflection of any instrument is determinded by the combined effect of the deflecting torque / force, control torque / force and damping torque / force.

* The value of deflecting torque must depend on the electrical signal to be measured.
* This torque / force cause the instrument movement to rotate from its zero position.

2. Controling torque / Force :-

* This torque / force must act in the opposite sense to the deflecting torque / force, and the movement will take up an equilibrium or definite position when the deflecting and controlling torque are equal in magnitude.

* The spinal spring or gravity usually provides the controlling torque.

3. Damping Torque / force :-

* A damping force is required to act in a direction opposite to the movement of the moving system.

* This brings the moving system to rest at the deflected position reasonably quickly without any oscillation or very small oscillation.

* This is provided by (i) Air friction.
(ii) Fluid friction.
(iii) Eddy current.

* It should be pointed out that any damping force shall not influence that steady state deflection produced by a given deflecting force or torque.

* Damping force increase with the angular velocity of the moving system, so that its effect is greatest when the rotation is rapid and zero when the system rotation is zero.

Basic meter movement OR D'Arsonval metter movement:-

Principle :- Whenever electrons flow through a conductor, a magnetic field proportional to the current is created. This effect is useful for measuring current and is employed in many practical meters.

* The basic dc meter movement is known as D'Arsonval, in making electrical measurement.

* This type of meter movement is a measuring device which is used in the ammeter, voltmeter, and ohmmeter.

* An ohmmeter is also basically a current measuring instrument, it differs from the ammeter and voltmeter in that it provides its own source of power and contains other auxiliary circuits.

D'ARSONVAL GALVANOMETER :-

This instrument is very commonly used in various methods of resistance measurement and also in d.c potentiometer work.

(1) Moving Coil :-

* It is the current carrying element.
* It is either rectangular or circular in shape and consists of number of turns of fine wire.
* This coil is suspended so that it is free to turn about its vertical axis of symmetry.
* It is arranged in a uniform, radial, horizontal magnetic field in the air gap between pole pieces of a permanent magnet and iron core.

* The iron core is spherical in shape if the coil is circular but is cylindrical if the coil is rectangular.

* In some galvanometers the iron core is omitted resulting in of decreased value of flux density and the coil is made narrower to decrease the air gap.

* Such a galvanometer is less sensitive, but its moments of intertia is smaller on account of its reduced radius and consequently a short periodic time.

(2) Damping :-

* There is a damping torque present owing to production of eddy currents in the metal former on which the coil is mounted.

* Damping is also obtained by connecting a low resistance across the galvanometer terminals.
* Damping torque depends upon the resistance and we can obtain critical damping by adjusting the value of resistance.

(3) Supension :-

* The coil is supported by a flat ribbon suspension which also carries current to the coil.
* The other current connection in a sensitive galvanometer is a coiled wire. This is called the lower supension and has a negligible torque effect.

* This type of galvanometer must be levelled carefully so that the coil hangs straight and centrally without rubbing the poles or the soft iron cylinder.

* This is not very strong mechanically so that the galvanometers must be handled carefully without jerks.

INDICATION :-

(4) The supension carries a small mirror upon which a beam of light is cast. The beam of light is reflected on a scale upon which the deflection is measured. This scale is usually about 1 meter away from the instrument, although 1/2 meter may be use for greater compactness.

(5) Zero Setting :-
* A torsion head is provided for adjusting the position of the coil and also for zero setting.

PMMC Instruments :-

* These instruments are used either as ammeters or voltmeters and are suitable for d.c work only.

* PMMC instrument work on the principle that, when a current carrying conductor is placed in a magnetic field, a mechanical force acts on the conductor.

* The current carrying coil, placed in magnetic field is attached to the moving system.

* With the movement of the coil, the pointer moves over the scale to indicate the electrical quantity being measured.

* This type of movement is known as D' Arsonval movement.

Construction :-

* It consits of a light rectangular coil of many turns of fine wire wound on an aluminium former inside which is an iron core as shown in fig.

* The coil is delicately pivoted. upon jewel bearings and is mounted between the poles of a permanent horse shoe magnet.

* Two soft-iron pole pieces are attached to these poles to conecentrate the magnetic field.

* The current is led in to and out of the coils by means of two control hair-springs, one above and other below the coil, as shown in fig.

* These spring also provide the controlling torque. The damping torque is provided by eddy currents induced in the alluminium former as the coil moves from one position to another.

WORKING :-

* When the instrument is connected in the circuit to measure current or voltage, the operating current flows through the coil.

* Since the current carrying coil is placed in the magnetic field of the permanent magnet, a mechanical torque acts on it.

* As a result of ~~the~~ this torque, the pointer attached to the moving system moves in clockwise direction over the graduated scale to indicate the value of current or voltage being measured.

* This type of instruments can be used to measure direct current only.

* This is because, since the direction of the field of permanent magnet is same, the deflecting torque also gets reversed, when the current in the coil reverses.

* Consequently, the pointer will try to deflect below zero. Deflection in the reverse direction can be prevented "a "stop" spring.

DEFLECTING TORQUE EQUATION :-

The magnetic field in the air gap is due to the presence of soft iron core. Thus, the conductors of the coil will move at right angles to the field. When the current is passed through the coil, forces act on its both sides which produce the deflecting torque.

Let B = flux density, wb/m^2

l = length of depth of coil, m

b = breadth of the coil.

N = no. of turns of the coil.

* If a current of 'I' Ampers flows in the coil, then the force acting on each coil side is given by

Force on each coil side, $F = BIN$ ~~Networks~~ Newtons.

* Deflecting torque, T_d = force × perpendicular distance

$= (BIN) \times b$

$T_d = BINA$ Newton meter.

Where, $A = l \times b$, the area of the coil in m^2

* Thus, $T_d \propto I$
* The instrument is spring controlled so that $T_c \propto \theta$
* The Pointer will comes to rest at a Position, where $T_d = T_c$
* Therefore, $\theta \propto I$.
* Thus, the deflection is directly propotional to the operating current.
* Hence, such instruments have uniform scale.

ADVANTAGES :-

(a) Uniform scale i.e, evenly divided scale.
(b) very effective eddy current damping.
(c) High efficiency.
(d) Require little Power for their operation.
(e) No hystensis loss (an the magnetic fields have little effects on the readings (as the operating magnetic field is very strong).
(g) Very accurate and reliable.

DISADVATAGES :-

(a) Cannot be used for a.c measurements.
(b) More expensive (about 50%) than the moving iron instruments because of their accurate design.
(c) Some errors are caused due to variations (with time or temperature) either in the strength of permanent magnet or in the control spring.

APPLICATIONS :-

(a) In the measurement of direct currents and voltages
(b) In d.c galvanometers to detect small currents.
(c) In Ballistic galvanometers used for measuring changes of magnetic flux linkages.

(2) OPERATION OF MOVING IRON INSTRUMENTS :-

Moving Iron instruments are mainly used for the measurement of alternating current and voltages, through it can also be used for d.c measurements.

PRINCIPLE OF MOVING IRON INSTRUMENT :-

* Let a plate or vane of soft iron or of high Permeability steel forms the moving element of the system.
* The iron vane is situated so as, it can move in a magnetic field Produced by a stationary coil.
* The Coil is excited by the current or voltage under measurement.
* When the coils is excited, it becomes an electromagnet and the iron vane moves in such a way so as to increase the flux of the electromagnet.
* Thus, the Vane tries to occupy a Position of minimum reluctance.
* Thus, the force produced is always in such a direction so as to increase the inductance of the coil.

Types of moving iron instruments :-

There are two types of moving-iron instruments

1. ATTRACTION TYPE :-

In this type of instrument, a single soft iron vane (moving iron) is mounted on the spindle, and is attracted towards the coil when operating current flows through it.

DEFLECTING TORQUE EQUATION :-

* The force F, pulling the soft-iron piece towards the coil is directly proportional to.
    (a) Field strength (H) produced by the coil.
    (b) Pole strength (m) developed in the iron piece.
* $F \propto mH$ since $m \propto H$,
* Therefore $F \propto H^2$
* Instantaneous deflecting torque $\propto H^2$.
* The field strength $H = \mu i$.
* If the permeability (μ) of the iron is assumed constant, then $H \propto I$. where $I \to$ instantaneous coil current (Ampere).
* Instantaneous deflecting torque $\propto i^2$.
* Average deflecting torque, $T_d \propto$ mean of I^2 over a cycle.
* Since the instrument is spring controlled, hence $T_c \propto \theta$.
* In the steady position of deflection, $T_d = T_c$.
* Therefore $\theta \propto$ mean of I^2 over a cycle $\Rightarrow \theta \propto I^2$ (mean of I^2 over a cycle $= I^2$).
* Since the deflection is proportional to the square of coil current, the scale of such instruments is non-uniform (being crowded in the beginning & spread out near the finishing end of the scale.

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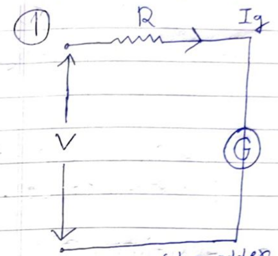
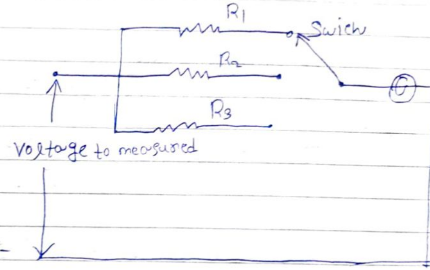
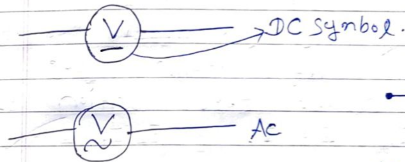
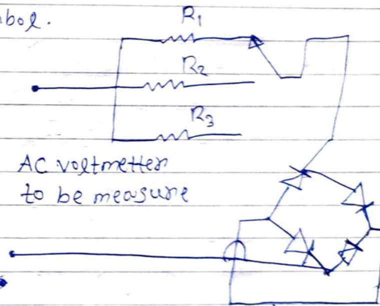


volt metter :-



multi DC voltmetter





Multi metter :-

* Is a multimeter is an electronics instrument which can measure current, Resistances, voltages.
* It is an in instrument and can be used for measuring DC as well as A.C voltages & current.

* Multimeter is the most in expensive ecument & can make various electrical measurement which measure

Functions:-

* A multimeter can measure voltages, current, resistances.

* To achive this objective parper circuits are conpereted with the galvano mettar.

* The Galvanomettar is a multimeter

* that is normaly its ~~§ a retudi~~ neddle rest in extrim left position as compaired to center zero position of ordinary galvano metter.

* multi metter as voltmeter. when high resistance (R) is connected are series with a galvano metter in becomes a volt meter.

* If Ig is the full scale deplesion current then the Galvano meter becomes a volt metter. (0 - Vo volt).

* The Req

* ~~Vo I~~

(1) $V = I_g R + I_g G$

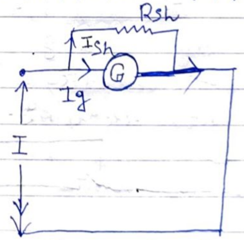
$\Rightarrow$ ~~R = R~~

$\Rightarrow I_g R = I_g G - V$

$\Rightarrow$

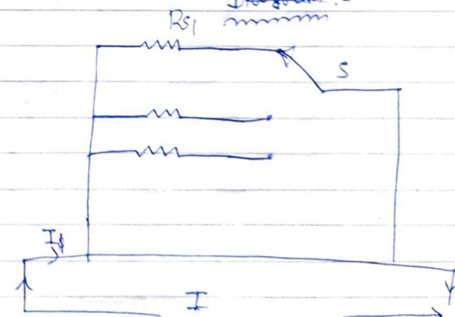
$$R = \frac{V}{I_g} - G$$

Multimetter & Amitor :-



single range Amitor

~~Diagram~~ :-



multi range

* When a low resistance is conected in parallal with an galvanometter it becomes an amitor.

* If (Ig) is the full scale reflection current when the galvanometer because an amitor of range

(0 – I) Amp.

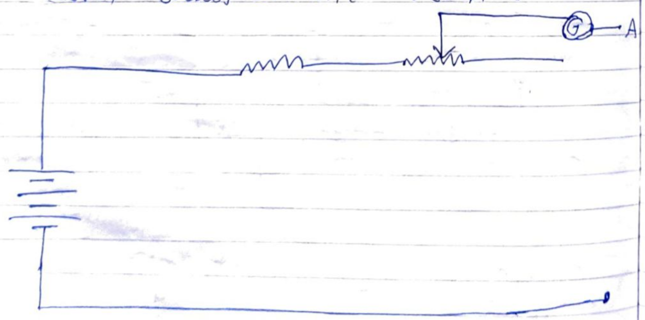
* The value of shut - resistance

Multimetter as ohm metter :-

* circuit source an ohm metter the multi metter emplose internal Battery

* A fix resistance (R) & variable resistor (r) are connected in siries with Battary & the Galvanometter.

* The fix resistance (R) limit the current with in the range dised & variable resistance (r) each for (zero) addjustment reading.



* The Resistance to be measure is connected between the terminal.
* The current flowing to the circuit the dependents.
Value of Resistor connected across the terminal.

* The ohm's metter made multi range instrument using different value of 'R'.

*

Applications of multimetter :-

The use of multimeter include the following.
* AC/DC voltage measurement.
* AC/DC current measurement.
* Resistance & continuity measurement
* To check diode.
* measurement of capacitance.
* measurement of frequency.
* To test batteries.
* A broken power cable can be determined.
* The switch can be tested.
* An outlet can be tested.
* old incandescent type light builbs can be tested.
* It used in the application of enviroment and temperature.

* measurement of time & frequency.

Dt - 31.10.22

Senecityvity :-

The resistance offered per volt off full scale reflection by the multimetter is known as multimetter senecityvity.

* metter Sencitivity indicate the internal resistance of the multimetter.

* Example -
If the Total resistance of the metter is 5000 Ω & metter is to read 50 volts ω then internal resistance of the metter is 1,000 Ω / V

* If the metter sencitivity is 400 Ω / per volt which reads (0 - 100) volt

Then metter resistance in 40,000 Ω

* V = metter is to read V volt I_g is = the full scale deflection current.

V = volts
I_g = current

R_m Metter	$\frac{V}{I_g}$

* Metter sencitivity is equal to resistance per volt full scale deflection.

$$\frac{V}{I_g} / V = \frac{I}{I_g}$$

* If the sencitivity of the multimetter is high it beings that it has high internal resistance.

METTER PROTECTION

(1) A multi metter has full scale deflection current on 1mA determind is sencitivity

Let I = 1mA

$$R_m = \frac{1}{1 mA} = \frac{1}{10^{-3}} = \frac{1}{1/1000}$$

$$= \boxed{1000 \Omega / volt} \rightarrow unit$$

(2) A multimetter has a sencitivity is 1,000 Ω/volts and reads 50 volt wh If the metter it to be used to measure the voltage across 50,000 Ω resister whi we need read currectly?

H.W

(1) Briefly explain PMMC meter?

(2) Briefly explain M.I instrument?

(3) Briefly explain Acctration type M.I instrument?

(4) Briefly explain repulsion type M.I instrument?

(5) Compairsion of moving iron & moving coil?

(1) PM

(1) Briefly explain PMMC meter?

* These instruments are used either as ammeters or voltmeters and ~~are used~~ are suitable for d.c work only.
* PMMC instruments work on the principle that, when a current carrying conductor is placed in a magnetic field, a mechanical force acts on the conductor.
* The current carrying coil, placed in magnetic field is attached to the moving system.
* With the movement of the coil, the pointer moves over the scale to indicate the electrical quantity being measured.

* This type of movement is known as D' Arsenoval movement.

Construction :-

* It consists of a light rectangular coil of many turns of fine wire wound on an aluminium foromer inside which is an iron core as shown in fig
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* Two soft-iron pole pieces are attached to these poles to concentrate the magnetic field.

* The current is led in to and out of the coils by means of two control hair-springs, one above and other below the coil, as shown in fig.

* These spring also provide the controlling torque. The damping torque is provided by eddy current induced in the alluminium former as the coil moves from one position to another.

Working :-

* When the instrument is connected in the circuit to measure current or voltage, the operating current flows through the coil.
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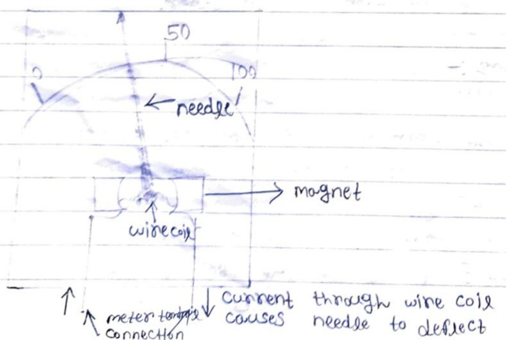
* Consequently, the pointer will try to deflect below zero zero. Deflection in the reverse direction can be prevented by a "stop" spring.

Permanent magnet, moving coil PMMC meter movement:-



Advantages :-

(a) Uniform scale. ie, evenly divided scale.
(b) very effective eddy current damping.
(c) High efficiency.
(d) Require little power for their operation.
(e) No hysteresis loss (as the magnetic field is constant).
(f) External stray fields have little effects on the readings (as the operation magnetic field is very strong).

(g) very accurate & reliable.

~~DisA~~

Disadvantages :-

(a) cannot be used for a.c measurements.
(b) more expensive (about 50%) than the moving iron instruments because of their accurate design.
(c) Some erros are caused due to variations (with time or temperature) either in strength of permanent magnet or in the control spring.

Applications :-

(a) In the measurment of direct currents & voltages.
(b) In d.c galvanometers to detect small currents.
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(2) Briefly explain M.I instrument ?

Ans:- * Moving iron instrument are mainly used for the measurement of alternating currents & voltages, through it can also be used for d.c measurements.

Principle of moving iron instrument :-

* Let a plate or vane of soft iron of high permeability steel forms the moving element of the system.

* The iron vane is situated so as, it can move in a magnetic field produced by a stationary coil.
* The coil is excited by the current or voltage under measurement.
* When the coil is excited, it becomes an electro-magnet and the iron vane moves in such a way so as to increase the flux of the electromagnet.
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Types of moving iron instruments :-

There are two types of moving - iron instruments.

1. Attraction type :-

In this type of instrument, a single soft iron vane (moving iron) is mounted on the spindle, and is attracted towards the coil when operating current flows through it.

~~2. Deflecting Torque Equations :-~~

2. Repulsion Type :-

* In this two soft iron vanes are used ; one fixed & attached the stationary coil, while the other is movable (moving iron), and mounted on the spindle of the instrument.

* When operating at the current flows through the coil, the two vanes are magnetized, developing similary polarity at the same ends.
* Consequently, repulsion takes place between the vans and the movable vane causes the pointer to move over the scale.
* It is of two types:-
(a) Radial vane type :- vanes are radial strips of iron.
(b) Co-axial Vane type :- Vanes are sections of coaxital cylinders.

(3) Briefly explain Attraction type M.I instrument?

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Deflecting torque equations:-

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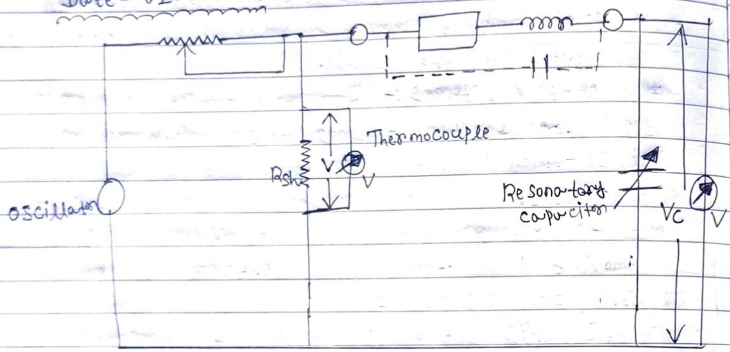
Date - 01. Nov. 22



Q meter :-

* Q meter is an instrument that is design to measure the quality factor direactly and it is use full in measunering the caractenstic of coils & capacitors.

* Q meter is also known as RLC meter, LCR meter or quality meter. It is use to measure quality factor of coils & resistance, capacitance & inductance of an electri circuit at radio frequency.

* Basic Principle of resonance it's used in the measurement of Q. At resonance the voltage across the tank circuit is Q time the applied voltage.

* Therefour by applying a fixed voltage to a circuit. The voltage across the capacity can be calib in terms of Q.

* The magnification factor Q of the circuit is defined as

$$Q = \frac{X_L}{R} = \frac{X_C}{R} = \frac{E_C}{R}$$

* At resonance $(X_L = X_C)$ & $(E_L = IX_L)$, $(E_C = IX_C)$

E_C = Capacitor voltage.
E_L = Inductive voltage.
X_L = Inductive reactance.
X_C = Capacity reactance.

$$Q = \frac{X_L}{R} = \frac{X_C}{R} = \frac{E_C}{R}$$

Working Principle :-

The working principle Q meter is series resonance the resonant because the resonant exists with in the circuit one's the reaction

& the capacitance reactance & inductance same magnitude. They induce energy to oscilate in between the fixed of the elective & magnetic

* This meter mainly detect of the features of the capacitance & resistance of the resonance series circuit.

③

Moving coil instrument	moving iron instrument
(1) It works on the principle of DC motor	(1) It works on the principles of magnetism.
(2) Deflection torque is proportional to current.	(2) Deflection torque proportional to the square of the current.
(3) Damping is provided by the eddy current.	(3) Damping is provided by air damping.
(4) Spring controlled	(4) Gravity controller.
~~(5) Damping is~~	
(5) Costly	(5) Cheap.
(6) It is used only in D.C circuits.	(6) it is used both in AC & DC circuits.
(7) uniform scale.	(7) Non-Uniform scale.
(8) Delicate, sensitive & accurate.	(8) Robust, reliable and accurate.
(9) Low power consumption	(9) High power consumption the moving coil.
(10) can be used a voltmeter, Ammeter, Galvanometer, ohmmeter.	(10) can be used as Ammeter, voltmeter & wattmeter.

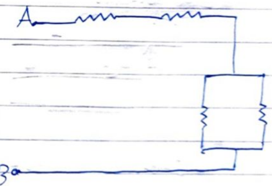
Date – 02. Nov. 22 :-

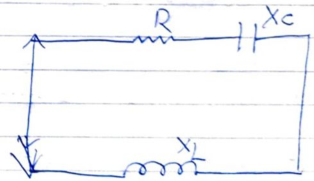
$X_C = \frac{1}{2\pi f C}$ — F

* 1 farad – 10^6 f

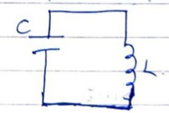
* $X_L = 2\pi f L$ — Hz
(Ω)

Impendance (Z)





Tank circuit :-



* Working – Frequency generate.

Application of Q meter :-

* It is used to measure the quality factor of the inducter.

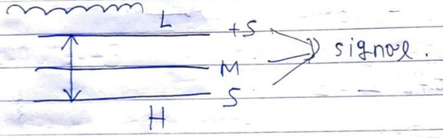
* By using this meter unknown resisto impedance can be measure using a series or shunt. (Parallel) & substitution method.

*

* It is used to measure small capacitor value.

* By using this inductance, effective resistance, self capacitance & band-width can be measure.

Bandwith



Distance between Lower cutup & higher cut up is

H.W Short question :-

(1) What is quality factor.?

(2) What is Q-meter ?

(3) What is the Q-meter working principle ?

(4) What is the Q-factor of a series resonant circuit.

H.W

(1) What is quality factor ?

Ans- The Q factor is a measure of the damping of resonator modes. Using super mirros, for example, optical resonators with extremely high Q factor can be made.

* Q-factor $= \frac{I_m X_L}{I_m R} = \frac{X_L}{R}$

* Q-factor $= \frac{L}{R\sqrt{LC}}$

* Q.factor $= \frac{1}{R}\sqrt{\frac{L}{C}}$

(2) What is Q-metter ?

Ans- Quality management ensures that an organization, product or service consistently functions well. It has four main components consistently function well.

* It has four main components : quality planning, quality assurance, quality control and quality and quality improvement.
* Quality management is focused not only on product and service quality, but also on the means to achieve it.

(3) What is the Q-meter working principle ?

Ans- Q meter works on the principle of series resonance. At series resonance, the voltage across capacitor is equal to Q times of applied input voltage. Thus, we can measure the value of Q directly by connecting a voltmeter across capacitor.

(4) What is the Q-meter Q-factor of a series resonant circuit?

Ans - The quality factor Q is defined as the ratio of the resonant frequency to the bandwidth, i.e. Q = wr BW. For a series RLC circuit resonant frequency is given by: wr = 1 LC.

Date - 07. Nov. 22 :-

CHACTER-3	Digital Instrument	CHAPCTER-3

* Digital instrument

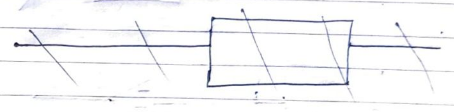
RAMP TYPE DVM :- (DVM stand form digital Volt meter)

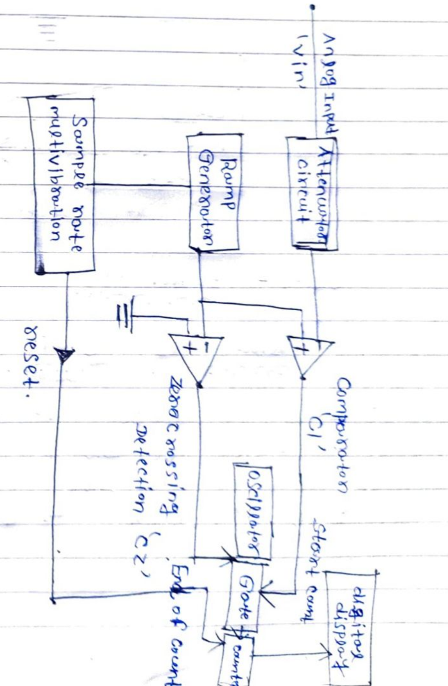
* The principle of operation of a Ramp type DVM is to measure the time that linear Ramp voltage text to change from the leoble of zero voltage 2, 0 voltage (or vice versal).

* This interval of time is measure with an electronic time interval counter. & the count is displyed as a number of digits on electronic indicreative turns.

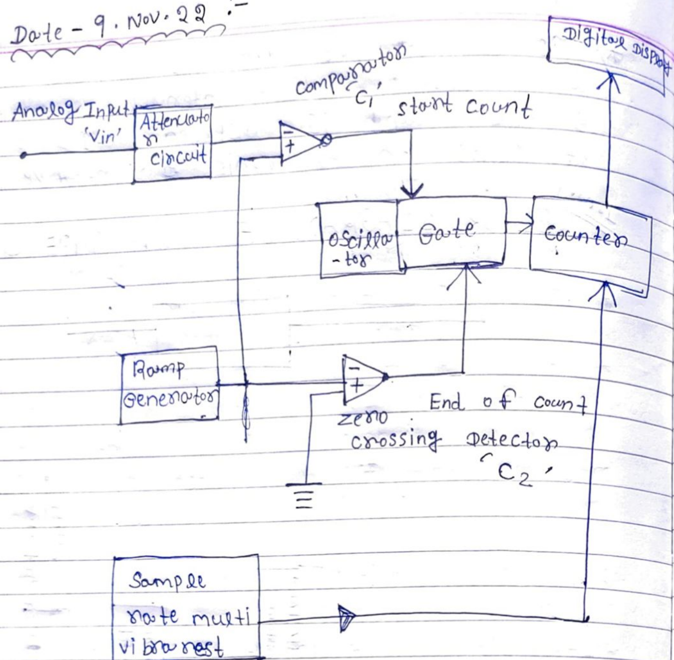
I.m.P

BLOCK DIAGRAM OF RAMP TYPE DVM :-





Date - 9. Nov. 22 :-



Date - 09. Nov. 22

What is D.V.M (digital volt meter) :-

* It is a device use for measuring the magnitude of D.C Voltage, AC voltage & can be measure after Rectification and Convession to D.C form.

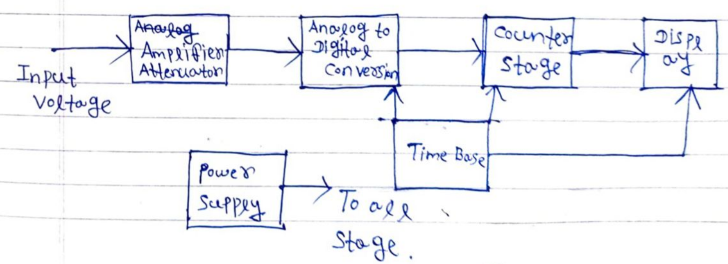
and conversion to D.C form.

* DC/AC current can be measure by passing them through a a known resistance (Internally & or extranally). and determinding the voltage develop across the resistance ($V = IR$).

* The Result of the measurement is display on a digital in numeric form as in the case of the counters.

* Most D.V.M s use in the principle of time period measurement. Hence The voltage is converted it to time interval (t) first. No frequency division in form. input range selection automaticaly changes the position of the decimal point on the display. The unit of measure is also highleted in most devices to simplify the reading.

Block diagram of DVM :-



* The Block diagram Shown principle of operation of a digital volt meter. It is compost of an amplifier, analog to digital convert, storage, display and timing circuit.

* Their is also a power supply to provied a electrical power to run electronic components.

* The circuit component except the analog to digital convert circuit are semilar to to the once used in electronic counters.

* The input range selection can be manual switched betn ranges to get most accurate reading or it can be autoranginge that switches ranges automatically for best reading.

Date - 15.11.22 :-

~~prin~~

~~Princi~~

Principle of RAMP TYPE DVM :-

* The operanting to principle of Ram type

It is to measure to time that linear Ramp Voltage . takes to Chainge from the leable of the input voltage to zero Voltag (vice versal)

Why ~~it~~ is called so ?

* Tha hert of the circuit is the Ramp genarator. this input fed to the rainging and Attencuator circuit which will be amplify ~~it~~ if it is smoll or Atternate the siangnal if it is

The input which should be measure is ~~eve~~ give in at the input voltage. Therefore it is called Ramp type D.V.M .

* Measure essential parts of D.V.M .
It has to measure section as the voltage to time conversion & Time measurement unit. The conversion unit has a Ram generator that operetes under the control of sample

-rate ossc, two comparator and a gate control circuit.

* Figure shown the The functional block diagram of a Ram-type D.V.M it has to measure sections as the voltage to time conversion unit & Time measurement unit.

* The conversion unit as a Ram generator that operates under the control of samplerate osci, two Comparators and a gate control circuit.

* The internaly

H.W ① write the Addvantage & Disaddvantage of Ram-type D.V.M ?
② write the different betn Angog & Digital multimeter ?

H.W answer :-

①

Addavantage & D.V.M :-

(1) Conversion time is very small.
(2) Conversion time is constant and independent of the ampeitude of the anlog input signal VA.
(3) errors on account of parallax and approximations are entirely eliminated.
(4) Operating speed is increased.
(5) Data can be fed to memory devices for storage and future computation.
(6) size reduced after the advantage of ICs and essily portable.

Disaddvantage D.V.M :-

(1) Conversion time is very small.
~~(2) Conversion time ~~of~~ is constant and independent of the ampeitude of the analog input signal VA.~~

(2) The conversion time is more compared to flash type ADC.
(3) Requires external power source.
(4) Excessive voltage can damage meter.
(5) Limitations due to the sampling rate.

Internal

(2) Analog Multimeter	Digital Multimeter
(1) This displays the calculated values through the deflection of the Pointer.	(1) The output of the meter is shown in the form of digits.
(2) In this meter, an analog to digital converter does not exist.	(2) It used to measure the 2 or more than 2 electrical terms like volts resistance and current.
(3) It used to finds the values of different electrical terms lie volts, current frequency.	(3) It mostly employed in industries.
(4) Its main component includes the function of volts, resistance, and ampere.	(4) It ~~has~~ requires an analog to digital converter to show values.
	(5) It has four main parts display buttons dial and input jack.
(5) It helps to solve electronic and electrical faults.	(6) Its accuracy in the calculation as compared to the analog meter is large.
(6) The latest meter helps to measure capacitor diodes testing.	~~(7) Its accuracy in the calculation as C~~
	(7) Its size is less than analog meter.

H.W

I.M.P

DSC

(1) A multimeter

(2) A multimeter has a sensitivity of 1,000 Ω per volt & read 50V full scale. If the meter is to be used to measure voltage across 50 kΩ resister ~~we~~ will it read correctly.

(3) If two 10 kΩ Resister is connect in series with 20 V supply find out current across 110 KΩ resister ?

(4) What is CRO ? (Cathod-Ray oscilloscope)

write short note :- (any five)

(1) What do you mean by indicating instrument?

(2) What is mean by deflecting torq ?

(3) How many types of torqe are there in an indicating instrument ?

(4) What do you mean by static characterstic?

(5) How can a moving coil metere be converted in to an ammeter?

(6) How many types of moving iron instrument are there?

(7) what is a multimetere?

Long questions (any two)

(1) Briefly explain principle an opperation of a moving coil instruement?

(2) Briefly explain principle an operation of a moving iron instrument?

(3) Write the difference between MC and MI Instrument?

Answer :-

Ans-

(1) What is an indicating instrument ?

Ans - An indicating instrument displays the instantaneous value of an electrical quantity on a pre-graduated scale, e.g. Voltmeter, ammeter, ohm-meter etc.

(2) What is meant by deflecting torque ?

Ans - The torque developed in the moving part of an instrument by the electrical quantity applied to the instrument is called deflecting torque.

Imp (3) How many types of torque are there in an indicating instrument ?

Ans - There are 3 types of torque in an indicating instrument:

(i) Deflecting torque.
(ii) Controlling torque.
(iii) Damping torque.

(6) How many types of of moving iron instrument are there ?

Ans - There are two types M.I instrument :-
(i) Attraction type (ii) Repulsion type.

Imp (7) What is multimeter ?

* Ans:- Multimeter is an electronics instrument which can measure current, voltage, & resistances.

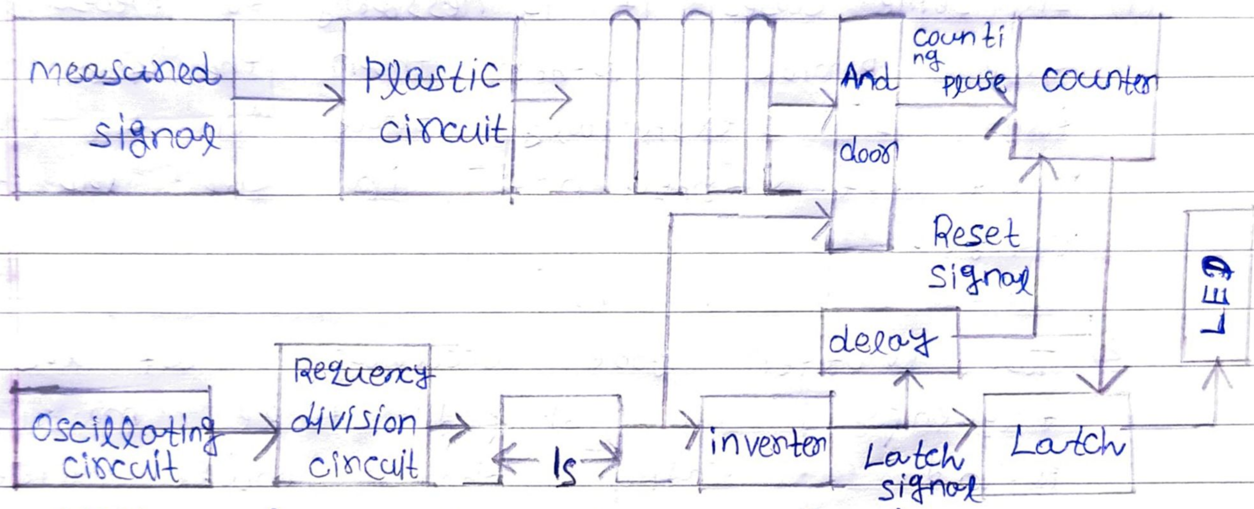
* It is an electronics instrument can be use for measuring D.C as well as A.C voltage & currents.

Date - 21 . Nov . 22

Measurement of

Digital frequency Meter :-

Diagram :-



* Digital frequency meter consider osci circuit & digital frequency division circuit

(1) OS , is the four of timemer, stability and the accuracy of frequency determined the timer accuracy (9-10) using IC 555 & RC constitude the osci which frequency is 5,000 HZ .

(2) Frequency division circuit - osci . produce a rectangle wave is 500 HZ, using frequency dividers to get 0.5 Hz timers signal, ~~74NS~~ 74LS90 this is a 2-5-10 decimal additions counter, use frequency dividers

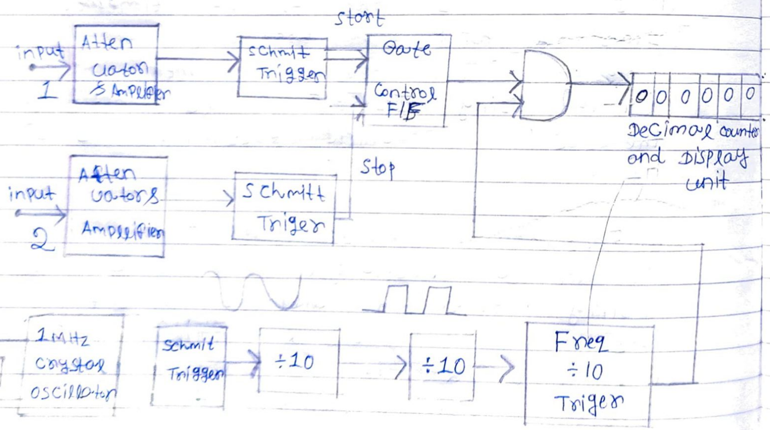
composed by 374LS90 can divided ~~[illegible]~~ 500 HZ rectangular plus in to Point 0.5 HZ.

Measurement of Time :-

① In some cases it is nessory to measure the time period rather than the frequency this is ~~s~~ especialy true in the measurement of frequency in the low frequency range.

② Two ~~a~~ often good accuracy, at low frequency we should take measurement period, rather than make direct frequency measurment.

Diagram :- Basic Block Diagram of Time measurement



Figures Sources the circuit for measurement of time period by ge'

Digital Tachometer :-

The Techenic employed in measuring the speed of a rooteing sharf~~td~~ is similar to the techenic used in a conventional frequerncy Counter, except that the selection of the gate period is in a with the RPM

* ~~Ao~~ That the rotating sharp P is the number of produce by pick-up from one ~~revolutio~~ revolution

Dt- 22. Nov.22 :- CRO

Cathod - ray

* It is versatile instrument or display measurement and anlysis of wave forms in electric an electronic circuit.
* The normal form of CRO uses horizontal input voltage which is an internally generated Ramp voltage called "time Base".

* This Horizontal voltage moves the luminous sport periodically in horizontal direction form left to Right over the display area form screen.

* Basically CRO is voltage operator device.

Operation of CRO :-

CRT - Cathod ray

* The CRO produces visual representation of electric current with the help of CRT (cathord) The main part of the CRO is cianity (cathod - ray).

-: Internal question :-

1)

(1) (a) How many types of torque are there indicating instrument?

Ans- * There 3 types of torque in an indicating instrument.

(i) Deflecting Torque.

(ii) Conctroling Torque.

(iii) Damping Torque.

(b) What is the multimeter? Write the use of a multimeter?

Ans:- * The multimeter is an electronics instrument which can measurement of current, voltage & Resistance.

* Which can measure of DC as well as AC voltage & current.

(c) Write the Fornula of % error of a instrument?

Ans- True

(d) Write the name of static characterstics of instrument?

Ans- The 7 type of static characterstic.

(i) Accuracy.

(ii) Precision.

(iii) Repeatability.

(iv) Reproducibility.

(v) Sensitivity.

(vi) Resolution.

(vii) True value.

(e) What is digital multimeter?

Ans:-* Digital multimeters (DMM) have numeric displays and have made analog multimeters virtually obsolete as they are cheaper, more precise, and more physically robust than analog multimeters.

* Multimeters vary in size, features, and price. They can be portable handheld devices or highly-precise

bench instruments.

Long question :-

(2) (a) Briefly explain the function of moving coil instrument with diagram?

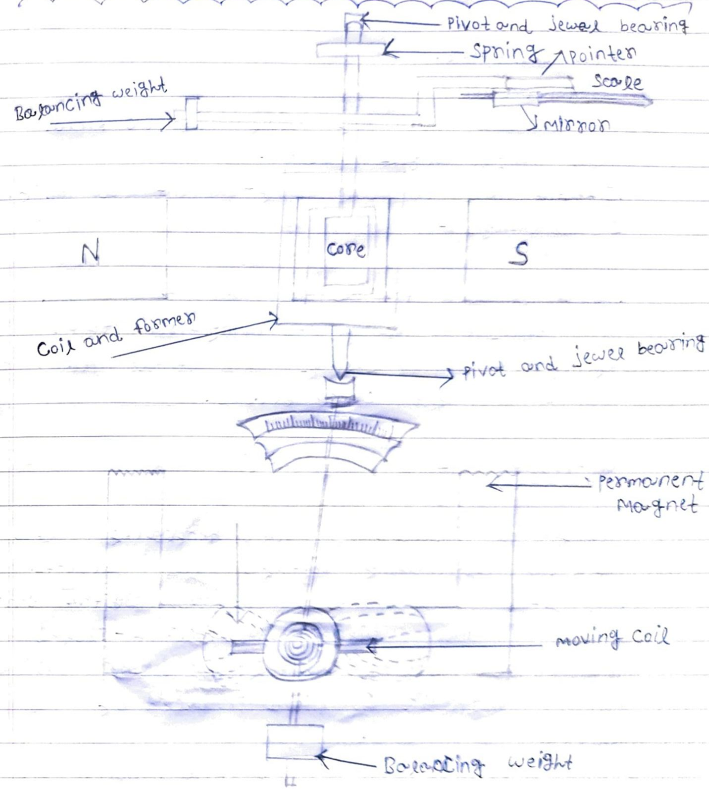
Ans :- Moving coil :-

Theory :-

* The Permanent magnet moving coil instrument is the most accurate type for d.c measurements. The working principle of these instruments is the same as that of d'Arsonval type of galvanometers, the difference being that a direct reading instrument is provided with a pointer and a scale.

* The moving coil is wound with many turns of enamelled on ~~skill~~ silk covered copper wire. The coil is mounted on a rectangular aluminium former which is pivoted on jewelled bearings. The coils move freely in the field of a permanent magnet. Most volter coils are wound on metal frames to provide the required electro-magnetic damping. Most ammeter coils, however, are wound on non-magnetic formers, because coil turns are effectively shorted by the ammeter shunt. The coil itself, therefore, provides electro-magnetic damping.

Diagram of Permanent magnet moving coil instrument.



Addvantages :-

(i) High sensitivity.
(ii) Uniform scale.
(iii) Well shielded from any stray magnetic field.
(iv) High torque/weight ratio.
(v) Effective and reliable eddy-current damping.

Disadvantages :-

(i) Cannot be used for ac measurement.
(ii) More expensive compared to moving-iron type.
(iii) Ageing of control springs and of the permanent magnets might cause errors.

application :-

moving-iron instruments are generally used to measure alternating voltages and currents. in moving-iron instruments the movable system consists of one or more pieces of specially-shaped soft iron, which are so pivoted as to be acted upon by the magnetic ~~so~~ field produced by the current in coil.

ⓑ Explain with diagram to function of moving iron instrument ?

Ans :-

Introduction :-

* The most common ammeters and voltmeters for laboratory or switch-board use at power frequencies are the moving iron instrument.
* These instruments can be constructed to measure measure current and voltage to an accuracy needed in most engineering works and still be cheap as compared with any other type of a.c instrument of same accuracy and ruggedness.

Classification of moving iron instruments :-

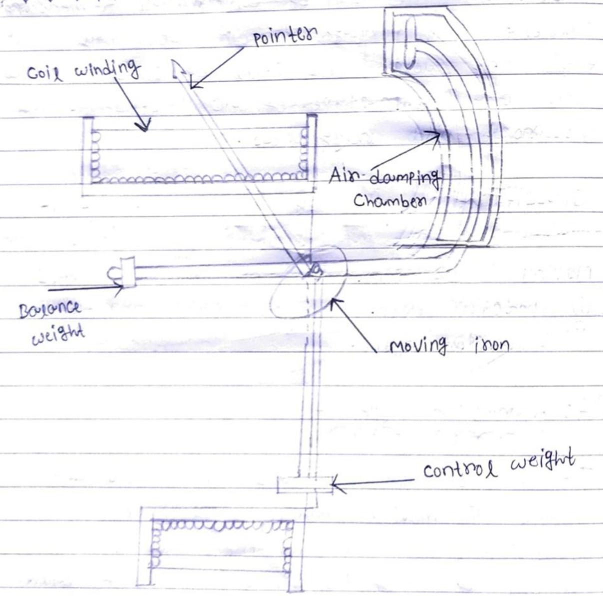
Moving iron instrument are of two types.
(i) Attraction type.
(ii) Repulsion type.

(1) ~~Ac~~ Attraction type :-

The coil is flat and has a narrow slot like opening. The moving iron is a flat disc or a sector eccentrically mounted. When the current flows through the coil, a magnetic field is produced and the moving iron moves from the weaker field outside damping is not used in them as introduction of a permanent magnet required for eddy current damping would distor the operating magnetic field.

coil to the stronger field inside it or in other words, the moving iron is attracted in. The controlling torque is provided by springs but gravity control can be used for panel type of instruments which are vertically mounted.

Attraction type moving iron instrument :-



(2) Repulsion type :-

In the repulsion type, there are two vanes inside the coil one fixed and other movable. These are similarly magnetised when the current flows through the coil and there is a force of repulsion between the two vanes resulting in the movement of the moving vane.

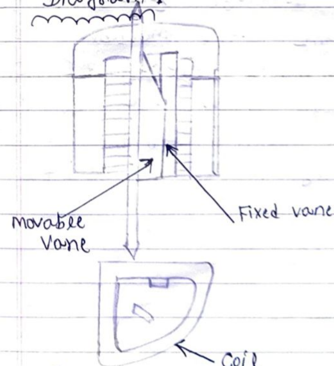
* Two different designs are in common use.

(i) Radial type :- In this type the vanes are radial strips of iron. The fixed vane is attached to the coil and the movable one to the spindle of the instrument.

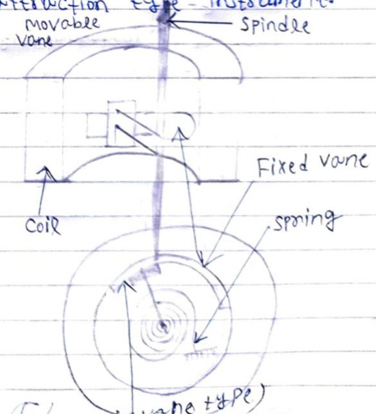
(ii) Co-axial vane type :- In this type of instrument, the fixed and moving vanes are sections of co-axial cylinders as shown in fig.

* The controlling torque is provided by springs. Gravity control can also be used in vertically mounted instruments. The damping torque is produced by air friction as in attraction type instrument.

Diagram :-



(a) (Radial vane type)



(b) (co-axial vane type)

Addvantage :-

* It is auniversal instrument which can be used for the measurements of AC and DC quantities.
* These types of instruments have high value of torque of torque to weight ratio. Due to this error because of friction is quite low.
* It is very Cheap due to simple construction.
* These instrument are quite robust due to its simple Construction.

dis addvantage :-

* The instruments suffer from error due to hysteresis, frequency change and stray losses.
* The scale of moving iron instrument is not uniform like PMMC instrument, its scale is non-uniform and cramped at lower end. This is the reason; accurate reading are not possible at lower range.

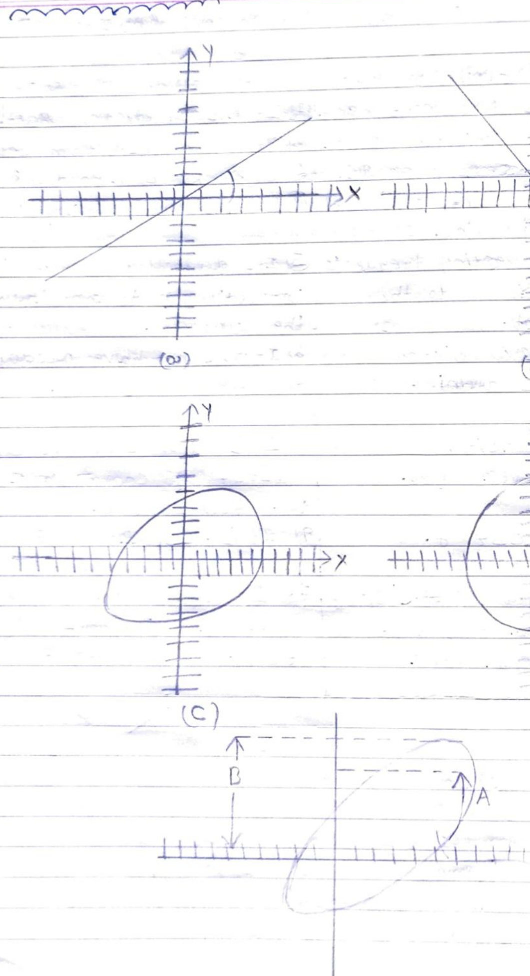
Application :-

moving-iron instruments are generally used to measure alternating voltage & currents. in moving-iron instruments the movable system consists of one or more pieces of specially-shaped soft iron, which are so pivoted as to be acted upon by the magnetic field produced by the current in coil.

© write the Comparison between M.C & M.I instrument?

Moving coil instruments	Moving iron instrument
① It has permanent magnet.	① It has an electromagnet.
② It has uniform scale.	② It has a non-uniform scale.
③ It works only on D.C.	③ It works both on A.C. & D.C.
(4) Eddy current are used for damping.	④ In this air damping is used.
⑤ Its deflecting torque is proportional to the current.	⑤ Its deflecting torque is proportional to the squar of the current.
⑥ It has a uniform torque	⑥ It does not have accuate torque
⑦ It has a ~~uni~~ low power loss.	⑦ Power loss is more.
⑧ It is sensitive cannot bear over load.	⑧ It is less sensitive, but it is robust & can bear overload for few seconds.
⑨ It is costly.	⑨ It is cheap.
⑩ Employed on D.C only as Ammeter, voltmeter and ohmmeter.	⑩ Employed on A.C. & D.C. as wattmeter & frequency meter etc.

Date - 28.11.22



OSCILLOSCOPE | CHAPTER-4 | OSCILLOSCOPE

CRO (Cathod-Ray Oscilloscope) :-

* It is the versatile instrument or display measurement and anlysis of wave forms in electronic an electronic circuit.

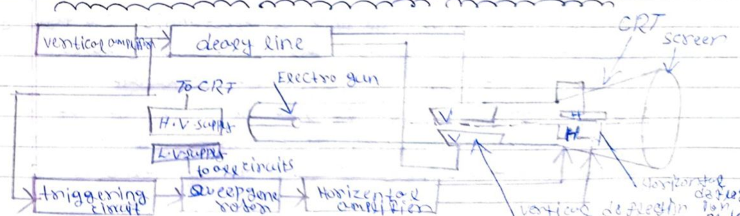
* The normal form of CRO uses Horizontal input voltage which is an internaly generated RAMP voltage Called ~~time~~ period "time base".

* This Horizontal voltage moves the luminous sport periodcaly in horizontal direction form left to Right over the display area form screen.
* Basicaly CRO is voltage operator device.

The Basic Principle of Oscilloscope :-

A CRO (Cathode - Ray oscilloscope), or DSO (digital storage oscilloscope), is a tye of electronic test instrument that observation of constantly varying singnal voltage, usually as a two-dimensional Plot of one or more signals as a function of time.

Block Diagram of Oscilloscope & simple CRO :-



* The oscilloscope can be adjusted so that repetitive signals can be observed as a continuous shape on the screen. ~~on the~~ A storage oscilloscope allows ~~sig~~ single events to be captured by the instrument and displayed for a relatively long time, allowing human observation of events too fast to be directly perceptible.

* oscilloscopes are used in the sciences, medicine, engineering and telecommunications industry. General-purpose instruments are used for maintenance of electronic equipment and laboratory work. Special-purpose oscilloscopes may be used for such purposes as analyzing an automotive ignition system or to display the waveform of the heartbeat as an electrocardiogram.

Dual Trace CRO :-

(1) Electronics gun. (single)
(2) Separate vertical input channels (two)
(3) Attenuators.
(4) Pr-amplifiers.
(5) Electronic switch.

* The two separate input signals can be applied to single electron gun with the help of electronic switching it produces a dual trace display. Each separate vertical input channel are uses separate attenuators and Pr-amplifier stages, so the amplitude of each signal can be independently controlled. output of the Pr-amplifiers is given to the electronic switch, which passes one signal at a time into the main vertical amplifier of the oscilloscope.

* The time base-generator is similar to that of single input oscilloscope.

* By using switch S2 the circuit can be triggered on either A or B channel, waveforms, or an external signal or on line frequency. The horizontal amplifier can be fed from sweep generator or from channel B by switching S1. when switch S1 is in channel B, itoscilloscope operate in the X-Y mode in which channel A acts as the vertical input signal andchannelBasthe horizontal inputssignal. from the front panel several operating modes can be selected for display, like channel B only.

* Channel A only, channels B and A as two traces, and signals A+B, A-B, B~A or (A+B) as a single trace. Two types of common operating mode are there for the electronic 1. Alternatemode.

Signal Analysis

- The analysis of electrical signals is used in many applications.
- The different instruments which are used for signal analysis are wave analysers, audio analysers & spectrum analysers, & modulation analysers.
- All signal analysis instruments measure the basic frequency properties of a signal.
- A spectrum analyser sweeps the signal frequency band and displays a plot of amplitude vs frequency having an operating range of about 0.02Hz - 250 GHz.
- A wave analyser is a voltmeter which can be accurately tuned to measure the amplitude of a single frequency, within a band of about 10 Hz - 40 MHz

Wave Analysers

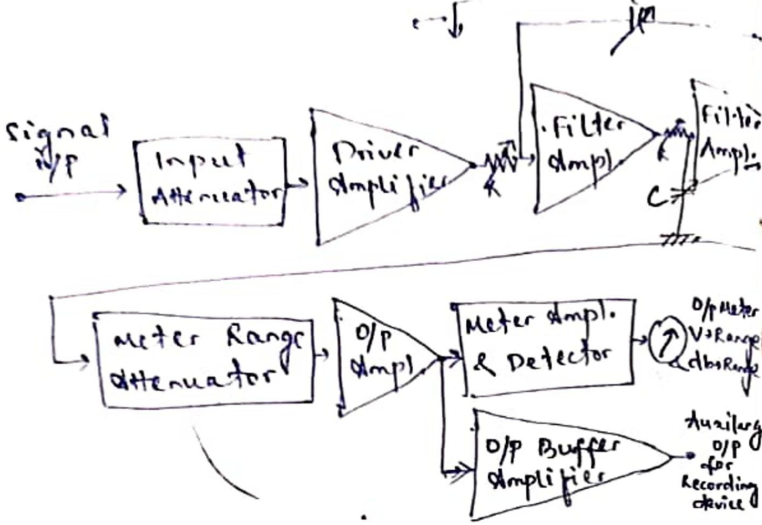
- Any periodic waveform can be represented as the sum of a d.c. component & a series of sinusoidal harmonics.
- Analysis of a waveform consists of determination of the values of amplitude, frequency & sometimes phase angle of the harmonic components.
- The analysis of a complex waveform can be done by electrical means using a band pass filter network to single out the various harmonic components. (29)
- A wave analyzer in fact is an instrument designed to measure relative amplitudes of single frequency components in a complex waveform.
- Basically the instrument acts as a frequency selective voltmeter, which is tuned to the frequency of one signal while rejecting all other signal components.
- The desired frequency is selected by a frequency calibrated dial to the point of maximum amplitude.
- The amplitude is indicated either by a suitable voltmeter or a CRO.

There are two types of wave analysers, depending upon the frequency ranges used, (i) Frequency selective wave analyser (ii) Heterodyne wave analyser

(i) Frequency selective wave analyser:

This wave analyser is used for measurements in the audio freq. range (i.e. from 20 Hz to 20 kHz)

The analyser has a filter section with a narrow pass band which can be tuned to the frequency of interest which is shown below.



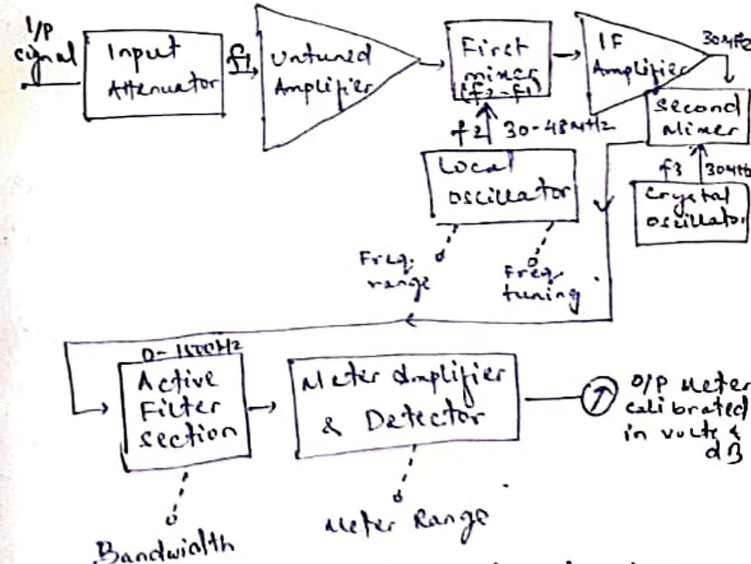
(a) Block dig. of Freq. sel. Wave Analyser

→ The waveform to be analysed in terms of its separate frequency components is applied to an i/p attenuator through a meter range switch adjustment on the front panel.
→ The purpose of the attenuator is to reduce the amplitude of power of RF signal without distorting the waveform.
→ A driver amplifier feeds the attenuated waveform to a high-Q active filter.
→ The filter consists of a cascaded arrangement of RC resonant sections & filter amplifiers.
→ The high Q filter is a low pass filter which allows the selected frequency to pass & reject all other.
→ The magnitude of the frequency is indicated by the meter & the filter section identifies the freq. of the component.
→ Precision potentiometers (Resistances) are used to tune the filter to any desired freq. within the selection passband.
→ The capacitor is for range changing & resistance is used to change the frequency within the filter.
→ A final amplifier stage supplies the selected signal to the meter ckt and to an untuned buffer amplifier.

→ The buffer amplifier can be used to drive a recorder or an electronic counter.
→ The meter is driven by an average type detector & usually has several voltage ranges as well as a decibel scale.

Heterodyne Wave Analyser.

→ Freq. selective wave analyser is useful for measurement in audio freq. range.
→ For frequency measurements in the megahertz range (RF range to MHz range), a heterodyne wave analyser (heterodyning (mixing)) is used.
→ A heterodyne wave analyser operates on freq. range from 10kHz to 18 MHz.
→ The i/p signal is fed through an attenuator & amplifier before being mixed with a local oscillator.



(Block dig. of the heterodyning wave analyzer)

→ The i/p signal enters the instrument through a probe connector that contains a unity-gain isolation amplifier.
→ After appropriate attenuation the i/p signal is heterodyned in the mixer stage with the signal from a local oscillator.
→ The o/p of the mixer forms an intermediate frequency (osc freq. − i/p signal freq: $f_o - f_i$) amplified by the 30 MHz IF amplifier.
→ This amplified IF signal is then mixed again with a 30 MHz crystal oscillator signal, which results in information centered on a zero freq.
→ An active filter with controlled bandwidth and symmetrical slopes of 72 dB per octave then passes the selected component to the meter amplifier & detector circuit.
→ The o/p from the meter detector can be read off a decibel calibration scale or may be applied to a recording device.

Applications of Wave Analysers :- (31)

Wave analysers have very important applications in the following fields:

(i) electrical measurements
(ii) sound measurements
(iii) vibration measurements

→ The wave analysers are applied industrially in the field of reduction of sound & vibrations generated by rotating electrical machines & apparatus.
→ The source of noise & vibrations is first identified by wave analysers before it can be reduced or eliminated.
→ Once these sources of sound and vibrations are detected with the help of wave analysers ways & means can be found to eliminate them.

Spectrum Analyzers :-

(i) Spectrum analysis is defined as the study of energy distribution across the frequency spectrum of a given electrical signal.
(ii) The study gives valuable information about bandwidth, effects of different types of modulation & spurious (false) signal generation.
(iii) The knowledge of the above quantities & phenomena are useful in the design & testing of Radio freq. (RF) & pulse circuits.

(iv) The spectrum analysis is divided into two major categories on account of instrumentation limitations & capabilities. They are -

- (1) Audio frequency (AF) analysis
- (2) Radio frequency (RF) analysis

The RF spectrum analysis covers a frequency range of 10 MHz to 40 GHz. & hence is more useful because it includes the vast majority of communication radar & industrial instrumentation frequency bands.

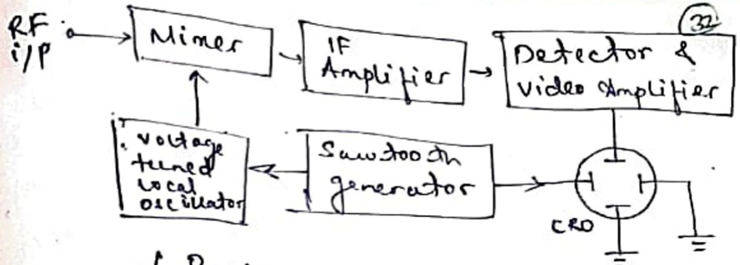
(v) The spectrum analyzer instruments find wide applications for measurement of attenuation, FM deviation & frequency in pulse studies.

Basic Spectrum Analyzer:-

→ The basic spectrum analyzer is designed to represent graphically a plot of amplitude versus frequency of a selected portion of the frequency spectrum under study.

→ The spectrum analysis of a signal provides the information about 1. Measurement of frequency & its response, 2. component levels, 3. Bandwidth 4. Frequency stability, 5. Harmonic & intermodulation distortion 6. Spectral purity, 7. Modulation index & attenuation

Modulation index → It is the ratio of peak amplitude of the modulating signal to the peak amplitude of the unmodulated carrier



(Basic swept receiver spectrum analyzer)

→ From the dig.

→ The ckt incorporates a sawtooth generator which supplies a ramp voltage to the frequency control element of the voltage tuned oscillator.

→ The local oscillator then sweeps through its frequency band at a linear rate.

→ The same sawtooth voltage is simultaneously applied to the horz. plates of the CRO.

→ The RF signal to be tested is appld. to the i/p of the mixer stage.

→ The sawtooth generator makes the local oscillator sweeps through its frequency band to beat with the i/p signal to produce the desired intermediate frequency (IF).

→ ~~An IF component is produced only when the co~~

→ The resulting IF signals are amplified, and detected.

→ After they are applied to the vertical deflection plates of the CRO thereby producing a display of amplitude vs freq. on the screen.

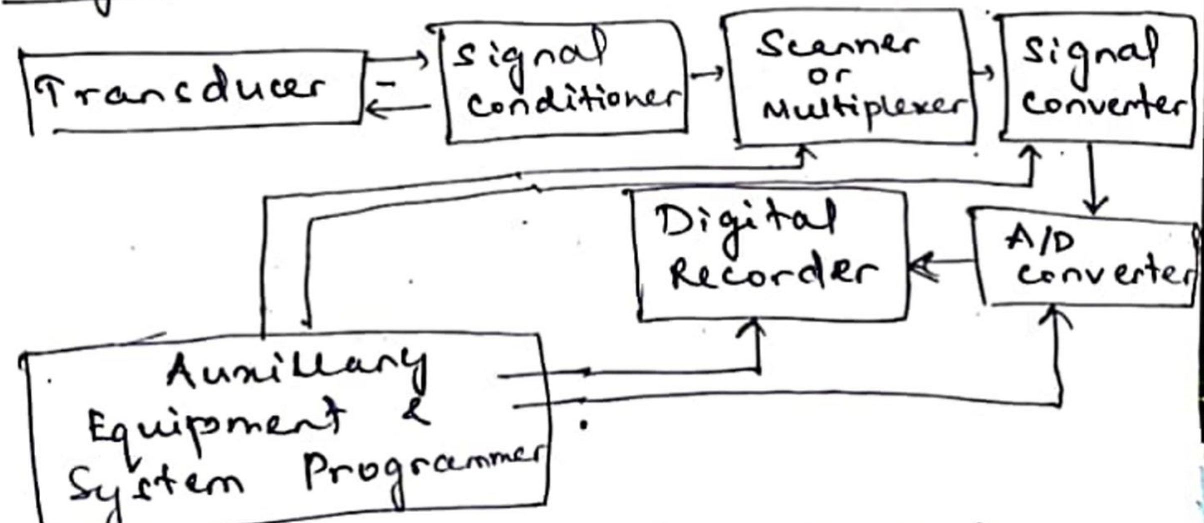
DIGITAL DATA ACQUISITION SYSTEM

Data acquisition systems are used to measure & record signals obtained in basically two ways.

(a) Signals originating from direct measurement of electrical quantities; which may include dc & ac voltages frequency or resistance & are found in electronic component testing environmental studies & quality analysis work.

(b) Signals originating from transducers such as strain gages & thermocouples.

Digital Data Acquisition System



(Elements of digital data acquisition system)

Transducer → Used for translating physical parameters into electrical signals.

Signal conditioner :- Generally supports or includes the supporting circuitry for the transducer. It is generally used for amplifying, modifying or selecting certain portions of the signal i.e. coming from the transducer.

Scanner or Multiplexer :- Accepts multiple analog inputs & generally sequentially connects them to one measuring instrument.

Signal converter :- Translates the analog signal to a form acceptable by the A/D converter. e.g.- is an amplifier for converting low level voltage ~~A/D converter~~ generated by thermocouples

A/D converter :- Converts the analog voltage to its equivalent digital form.

Auxilliary equipment :- This section contains instruments for system programming functions & digital data processing. This is perofor med by a digital computer

Digital recorder :- Records digital information on punched cards, magnetic tape, typewritten pages. (45)

→ The digital recorder may be preceded by a coupling unit that translates the digital information to the proper form for entry into the particular digital recorder selected.

Data acquisition systems are used in a large & ever-increasing number of applications in a variety of industrial & scientific areas, such as the biomedical, aerospace & telemetry industries.

Instrumentation Amplifier :-

In some cases the transducer output to some distance in an industrial environment, where there is large electrical machinery, the electrical noise present can cause serious difficulties in low level circuits.

→ These noises can be either radiated as an electromagnetic field or induced in the wiring of the plant as ground loops, and induced spikes on the ac power supply.

→ One effective method of combating noise is to increase the strength of low level