classwork:

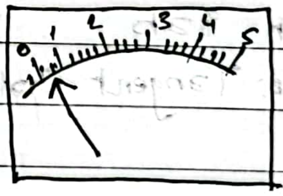
MODULE 01:

* Digital and Analog Instruments:

↳ Difference between Digital and analog Instruments:

	Digital	Analog
⟨i⟩	It gives the values in the form of specific order in digit form.	It gives the values in the form of deflection of pointer.
⟨ii⟩	It's data is accurate	It's values are not accurate
⟨iii⟩	In all modern equipments digital system instruments are used	It was used in older days.
⟨iv⟩	It cost higher than other	It is cheaper or less expensive than
⟨v⟩	It is easy to handel and use	It is not easy to handel and use.
vi	It's User friendly	It is not user friendly.
		Example: Voltmeter, Ammeter, Watt meter.

* Deflecting Torque
* Controlling Torque.
* Damping Torque.



* Work of Deflecting Torque:

→ It will help the deflection of pointer on the Calibrated Scale.

* Work of Controlling Torque.

→ It will controll the movement of the pointer on the calibrated Scale

* Damping Torque:

→ It will reduce the oscillation of the pointer on the calibrated sc

01/03/2023

Passbook

* ABSOLUTE INSTRUMENT
* SECONDARY INSTRUMENT

	ABSOLUTE Instrument	SECONDARY instrument
<i>	This instruments they do not give the reading directly but give interms of instrumental constants.	<i> These are the instruments whose output is measured to give the values of the quantities directly.
<ii>	Absolute instruments are more accurate as they do not change their values with respect to temp^r/. pressure	<ii> It's accuracy is less due to parallax error.
<iii>	Absolute instruments are used in research lab	<iii> Secondary instruments are used in academic lab
(iv)	Examples: Tangent Galvanometer,	(iv) Examples: Ammeter, voltmeter watt meter:

Instruments as per their applications are again categorised into Recording instrument, Indicating instrument, integrating instruments.

* Recording Instrument:
~~Indicating~~ These instruments are the instrument which will record the data which can be refried in future
Example: Seismograph.

* Integrating Instrument:
Integrating are the instruments it gives the output after integrating the instantaneous values with respect to time Example: Energy meter.

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Indicating : These instruments will indicate the instantaneous values when connected to a circuit.
Example: Ammeter, voltmeter, Watt meter.

classwork [Q] Find out more examples of indicating, Integrating & Recording instruments.

Ans → Integrating instrument →
Indicating Instruments →
Recording Instruments →

\# The methods of getting deflection on a pointer (indicating instrument)
(I) Magnetic Effect. (III) Induction Effect.
(II) Thermal Effect. (IV) Electrostatic Effect.

↳ When ammeter or voltmeter is in working condition the deflection of the pointer occurs due to the above effects as mentioned. As per magnetic field is present inside the instrument according to Faraday's law of electromagnetic induction an induced emf is produced in the coil this induced emf gives rise to current in the coil, as current is proportional to torque ~~gives~~ the pointer deflect on the calibrated scale, there torque is known as deflecting torque. $T_d \propto I$

$T_c \propto \theta$ (angle of deflection $= \theta$)

\# At steady state

$\boxed{T_d = T_c}$ ∴ deflecting torque = controlling torque.

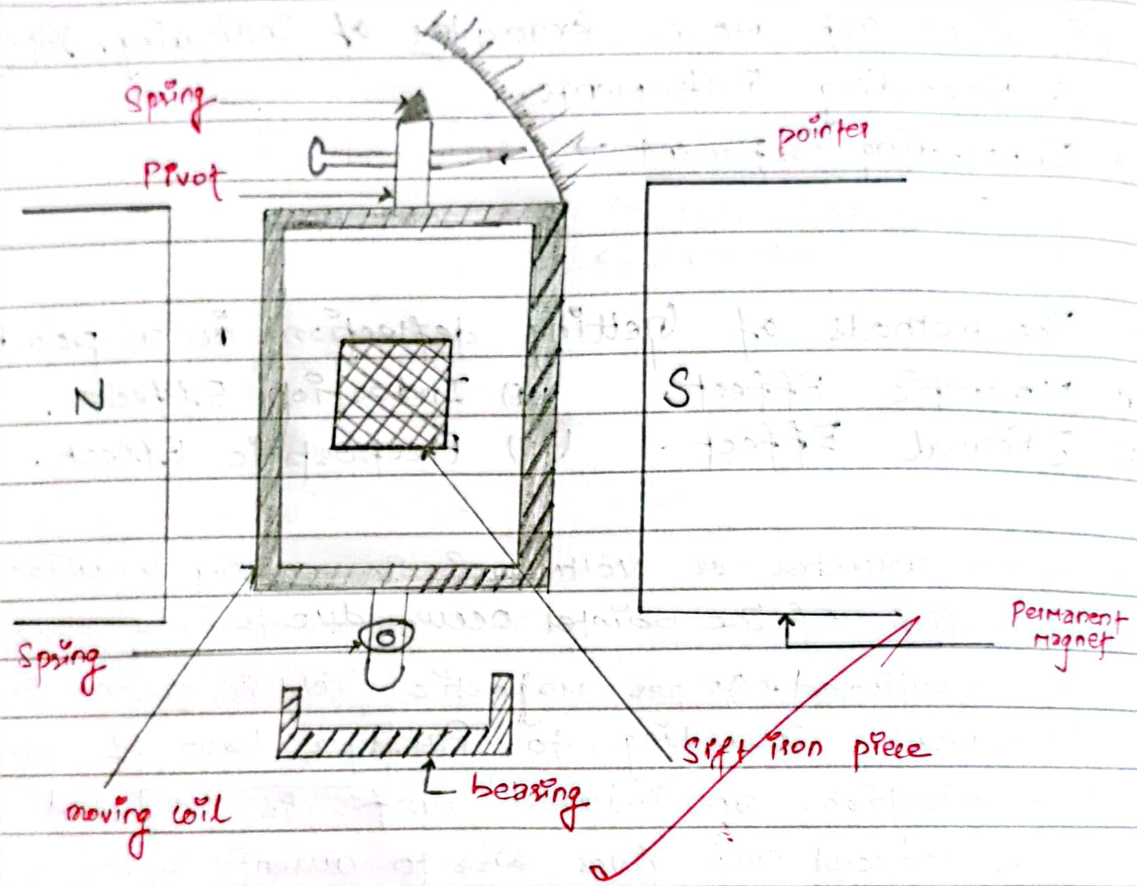
$\boxed{I \propto \theta}$ [∵ at steady state condition]

06/03/24

* According to the construction, instruments are of two types.

<i> Permanent magnet moving coil (PMMC)

<ii> Permanent magnet moving iron (PMMI)



→ As per the diagram the rectangular coil is placed inside the magnet field. which is produced from the parmanent magnet. In centre of the coil is attached to a soft iron piece which is rectangular in nature. The pointer is attached to two circular springs which produced controlling torque. In order to remove the frictional losses, bearings are kept in the circuit.

→ WORKING PRINCIPLE:

According to Faraday's law of electromagnetic induction whenever the coil moves inside a magnetic field, a force is being produced. This force produces induced emf in the coil. Due to this, induced emf. A current is produced in the coil. which is proportional to deflecting torque.

06/03/2025

So the pointer moves over the calibrated scale.

$T_d \propto I$

$T_c \propto \theta$

at steady state $T_d = T_c$

$\boxed{I \propto \theta}$

* Advantage
- Scale is uniform
- Power consumption is low
-

* Disadvantages:
- It can be used only in DC supply.
- It's cost is more compared to PMMI instrument.

Difference between

	"PMMC"		"PMMI"
1>	The iron path is stationary and coil is movable.	<1>	The iron path is movable and coil is stationary.
2>	PMMC instruments are used in DC supply only	<2>	They are used in both AC & DC
3>	It is expensive	<3>	It is cheaper
<4>	It's power consumption is less. $\boxed{I \propto \theta}$	<4>	It's power consumption is high. $\boxed{I^2 \propto \theta}$
<5>	Scale is uniform	<5>	Scale is non-uniform.
<6>	$T_d \propto I$	<6>	$T_d \propto I^2$

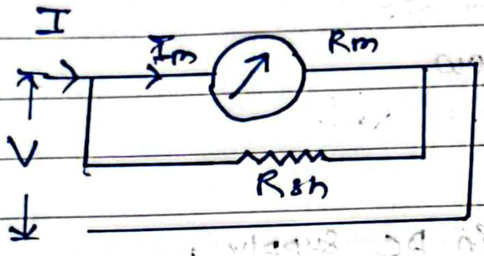
06/0?

* Extension of Range

It indicates the capability of the instrument to measure higher values.

* Extension of Range of Ammeter:

As the ammeter is connected in series to a circuit, a resistance called as a shunt resistance.



I = Input current

Rsh = shunt resistance

Im = meter current

Rm = meter resistance

V → input voltage.

$$I_m R_m = I_{sh} R_{sh}$$

$$\frac{I_m R_m}{I_{sh}} = R_{sh}$$

$$\frac{I_m R_m}{I - I_m} = R_{sh}$$

Q. A Millammeter of 2.5 ohm resistance measuring upto 10 milli-ampere. Calculate the resistance which is necessary to enable it to measure 10 ampere.

$$R_{sh} = \frac{I_m R_m}{I - I_m}$$

$R_m = 2.5$ ohm

$I = 10A$

$I_m = 10 \times 10^{-3} A$

$R_{sh} = ?$

$$= \frac{10 \times 10^{-3} \times 2.5}{10 - 10 \times 10^{-3}}$$

$$= \boxed{0.025\ \Omega}$$

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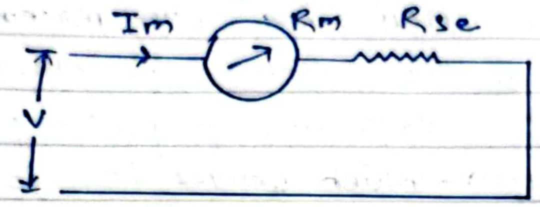
* Extension of Range of Voltmeter:



$$V = I_m(R_m + R_{se})$$

$$\frac{V}{I_m} = R_m + R_{se}$$

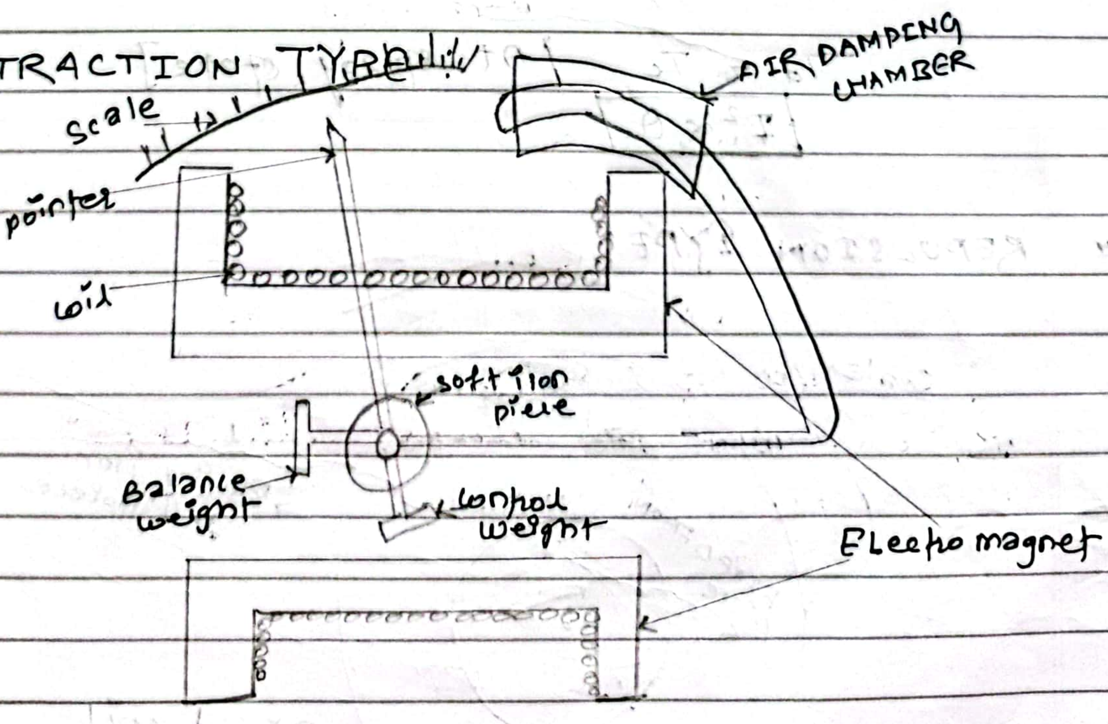
$$V/I_m - R_m = R_{se}$$

MOVING IRON TYPE INSTRUMENT

→ ATTRACTION TYPE

→ REPULSION TYPE

(1) ATTRACTION TYPE



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classwork

WORKING of attraction type: It is based on magnetic attraction which attracts an iron piece when placed near a magnetic field. Here magnetic fields are created by the electro magnets. The deflecting torque is produced due to this force of attraction which moves the pointer over the calibrated scale. The controlling torque is produced due to presence of the controlled weight and balanced weight attached to the spindle. The damping torque is produced due to presence of air friction damping chamber which reduces the oscillation of the pointer.

Deflecting torque Td

$$\boxed{T_d = \frac{1}{2} I^2 \frac{dL}{d\theta}}$$

where $I \rightarrow$ current through the coil
$L \rightarrow$ Inductance of coil
$\theta \rightarrow$ Angle of deflection

$$\boxed{T_c = K\theta}$$

$T_d = T_c$ [At steady state]

$$\boxed{I^2 \propto \theta}$$

REPULSION TYPE:

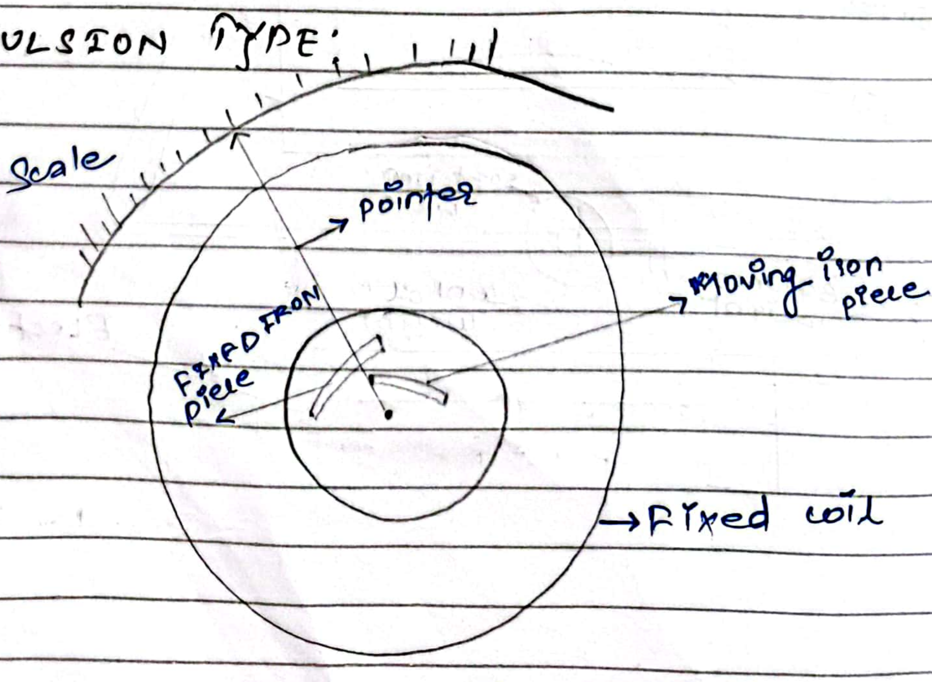

Fig: Repulsion Type:

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PRINCIPLE

WORKING: The repulsion type instrument includes two iron pieces where one is permanent or fixed an another is a movable one. The fixed iron piece is connected too the coil and the moving one is attached to the spindle, so the spindle carries the pointer to move on a calibrated scale, when no current is flowing through the coil the two iron pieces are joined together, when current is flowing through the coil a force of repulsion exist between two iron pieces, which creates the deflection of the pointer.

Deflecting Torque: $$\boxed{\tau_d = \frac{1}{2} I^2 \frac{dL}{d\theta}}$$

where I = current through the coil
L = inductance of coil
$\theta \rightarrow$ angle of deflection

$$\boxed{\tau_c = K\theta}$$

$\tau_d = \tau_c$ [At steady state]

$$\boxed{I^2 \propto \theta}$$

15/03/2023

* POWER MANAGEMENT:

* SINGLE PHASE & 3 PHASE POWER

$P_{DC} = VI$

$P_{AC} = VI\cos\phi$

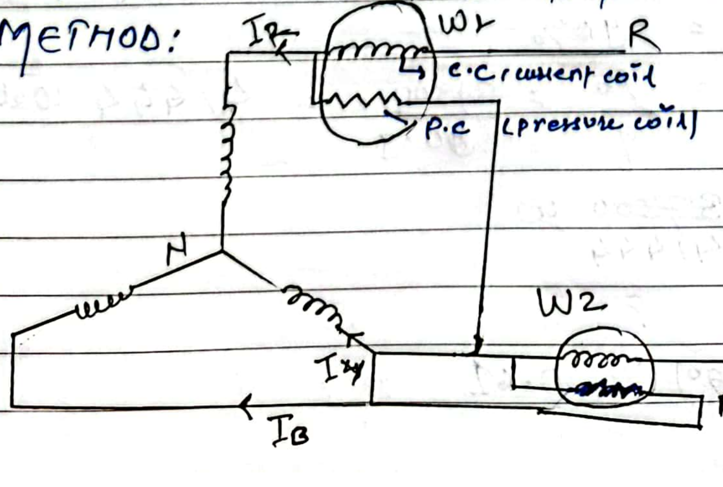
[3 phase is more benifical power consumption is less so it is benifical than singlephase]

$P_{AC,\,3\phi} = 3 V_{ph} I_{ph} \cos\phi$ - phase

$= \sqrt{3} V_L I_L \cos\phi$ - line

[Theory is important]

* 3 PHASE POWER MEASUREMENT BY TWO WATT METER METHOD:



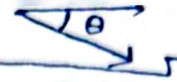
$\rightarrow$ star connection

$\curlywedge$ - star connection

$\triangle \rightarrow$ Delta connection

C.C { current coil }

P.C { pressure coil }



phase difference $\boxed{\tan\phi = \sqrt{3}\left(\frac{W_2 - W_1}{W_1 + W_2}\right)}$

3-φ power $\boxed{P = W_1 + W_2}$ Three phase power.

imp Q The two wattmeters connected to three phase induction motor are showing the readings as $W_1 = 2400W$, $W_2 = -1200W$. Calculate the total power & power factor of A.C circuit.

$$P = 2400 - 1200$$

1 Hp = 746 watt.

$$= 1200\ W$$

$$\tan\phi = \sqrt{3}\left(\frac{-1200 - 2400}{1200}\right)$$

$$= -3\sqrt{3}$$

$$\phi = -79.10 \approx -80$$

Power factor = $\cos\phi = \sqrt{3}\left(\frac{-1200 - 2400}{1200}\right)$

$$\phi = 0.188$$

Q The power factor of a given circuit is found to be 0.85 the output power is 50 Hp. Find out the readings of two watt meter if the system is 90% efficient.

Soln

$$\cos\phi = 0.85$$

$$\phi = \cos^{-1}(0.85) = 31.7^\circ$$

$$P_o = 50\ Hp = 50 \times 746\ W = 37300\ W$$

$$\eta = 90\%$$

$\eta = \frac{P_o}{P_{in}}$

$$P_{in} = \frac{P_o}{\eta} = \frac{37300}{0.9} = 41444\ \text{watt}$$

$$P_{in} = W_1 + W_2 = \cancel{37300}\ 41444\ W$$

$$\tan\phi = ?$$

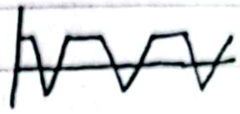
$$\tan(31.7^\circ) = 0.61$$

'classwork'

VVI

* DIGITAL VOLTMETER

RAMP DIGITAL VOLTMETER



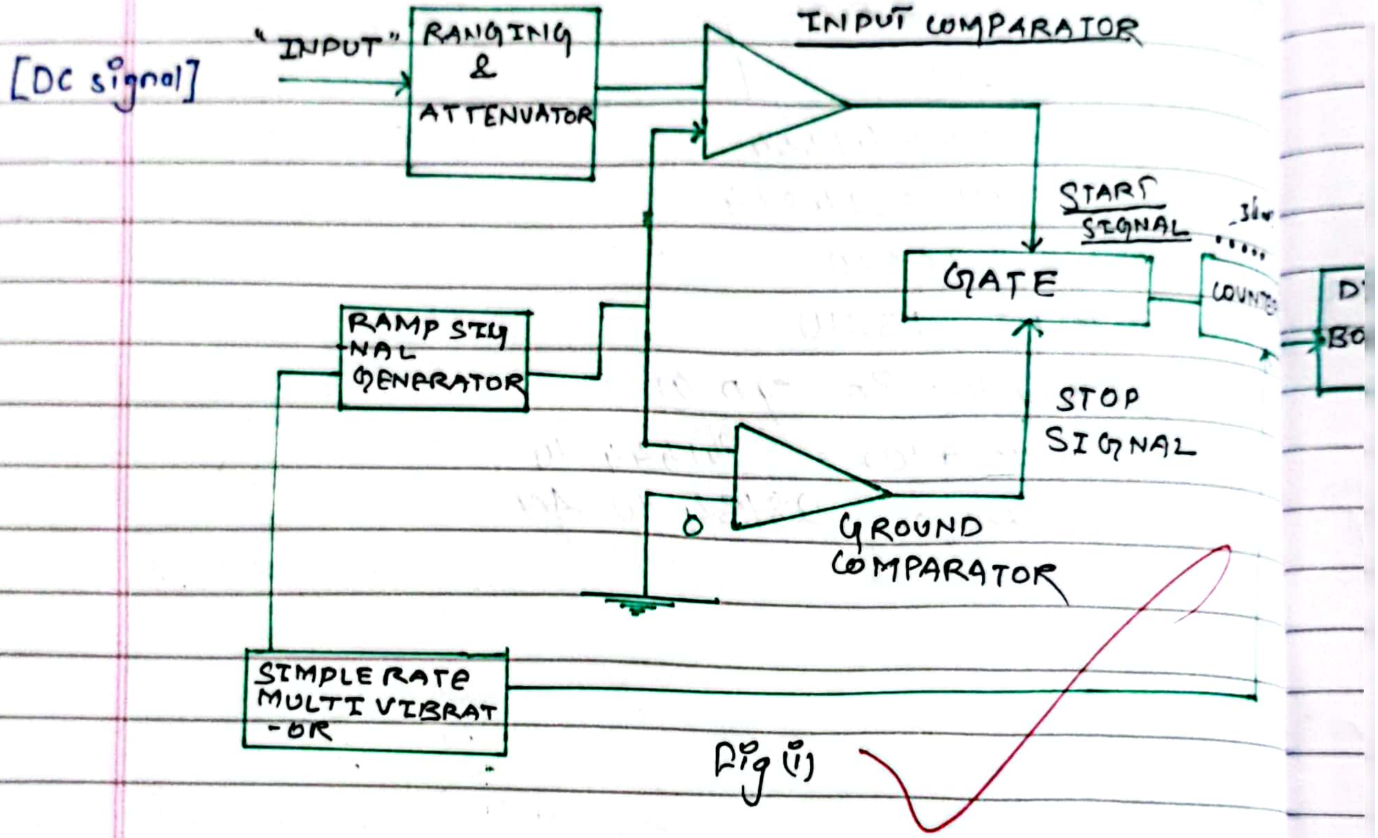


Fig (i)

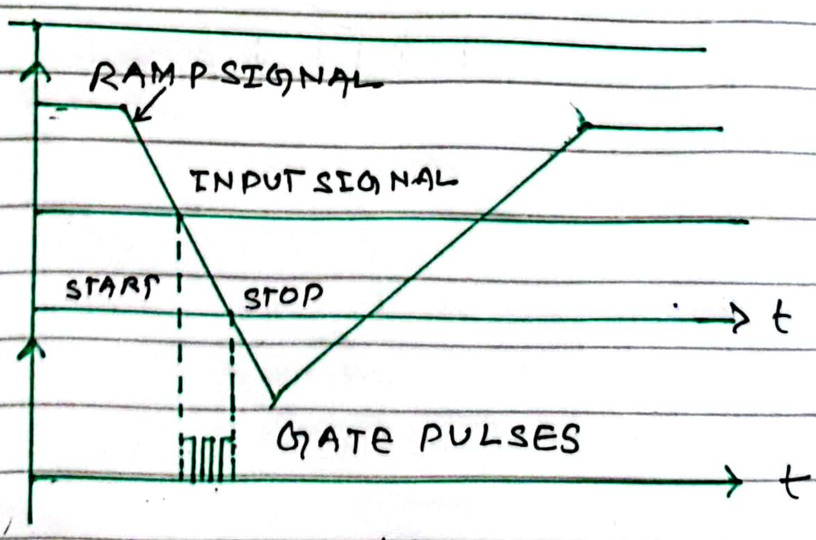


Fig (II)

* Theory : ~~Input~~

WORKING PRINCIPLE: * The input signal is the signal which has to be measured through the "DVM"

* The input signal is fed to ranging and attenuator

which amplifies or reduces the input signal

* The RAMP signal is generated through the RAMP Generator as shown in the figure (II)
* The input & the Ramp signal are fed to the input comparator which produces the start signal.
* The second comparator is known as GROUND Comparator. and it's one terminal is grounded. The ground comparator produces the stop [redacted] signal
* In between the start terminal and stop terminal a number of pulses are produced which passes through the gate terminal

DISPLAY BOARD

* The counter will count the no. of pulses it's receives from the gate terminal.
* The Display Board will show the value in terms of numericals such as 3, 20, 30, 50, 80 etc.
* The system is initialized by 'SAMPLE RATE MULTIVIBRATOR' Block.

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08/12/2079

* $3\frac{1}{2}$ bit display / $4\frac{1}{2}$ bit display

3 characteristics of DVM [Digital Volt meter]

→ Resolution imp
→ Sensitivity.
→ Accuracy. imp

* Resolution $R = \frac{1}{10^n}$

n = Full digit
$n = 3$
$R = \frac{1}{10^3} = 0.001$

Example 16.53234

$R = \frac{1}{10^2} = 0.01$
$= \boxed{16.53}$

half digit, full digit

$R = \frac{1}{10^3} = 0.001 \Rightarrow \boxed{16.532}$

$R = \frac{1}{10^5} = 0.00001 \Rightarrow \boxed{16.53234}$

20.468 $R = \frac{1}{10^3} = \boxed{20.468}$

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question ① Compare DVM with AVM? (0 - 200V Range)
② Mention some advantages of DVM?
③ Mention some disadvantages of DVM? [costly, handle carefully]

* $4\frac{1}{2}$ bit $R = \frac{1}{10^4} = 0.0001$

Resolution of $3\frac{1}{2}$ bit display $[R = \frac{1}{10^3} = 0.001]$
Resolution of $4\frac{1}{2}$ bit display $[R = \frac{1}{10^4} = 0.0001]$

↳ $3\frac{1}{2}$ bit display indicate it will show 3 digit after dec
↳ $4\frac{1}{2}$ bit display will show 4 digit after decimal

[Q] * What is the Resolution of $4\frac{1}{2}$ bit display board?
* How 16.95 Volt could be displayed on a 100V Range
$\boxed{0.6564}$ Volt on a 1V & 10V Range

Soln

① Ans $R = \frac{1}{R^4} = 0.0001$

For $1V = \frac{1}{R^4} =$
$10V = \frac{1}{R^4} \times 10$

② 16.95

1	6	.	9	5	0	0

$R = \frac{1}{10^n} = \frac{1}{10^4} = 0.0001$
For 1V

For 10V, $R = 0.0001 \times 10$
$= 0.001V$

$R = 100V = 0.01$

$\boxed{16.950}$

100V, $R = 0.01V$, $\boxed{16.95}$

0.6564 for 1V $R = \frac{1}{10^4} = 0.0001 \times 1$
$R = 0.00001$
0.6564

For 10V = 0.656

[Define Resolution]?

classmate

Date 22/03/2023
08/12/2079

For $3\frac{1}{2}$ bit $\quad R = \frac{1}{10^3} = 0.001 \times 100$

For 1 V $\quad R = \frac{1}{10^3} = 0.001 \times 1$

0.656 $\quad$ 1 Volt Range

For 10 V $\quad R = \frac{1}{10^3} = 0.001 \times 10$

0.01

0.65 $\quad$ 10 Volt Range

For 16.95

[0.001] in 1 V Range = 16.950

[0.01] 10 V = 16.95

[0.1] 100 V = 16.9

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Revision

(i) Absolute instruments.
(ii) Secondary instruments. } Analog
(iii) Analog instruments.
(iv) Digital instruments.

Analog , Digital
not accurate , more accurate
analog ammeter, analog voltmeter , Digital ammeter, Digital voltmeter

PMMC (PMMI)
→ moving coil instrument → moving iron instrument
→ coil moving inside the magnetic field → iron piece is moving in the magnetic field

(i) [Integrating Instrument]
[Indicating Instrument]
[Recording Instrument]

Controlling torque is produced by spring (spin) control and also gravity (balance weight) control. [Spring controll & gravity controll.] ← controlling torque

steady $I_d \propto T_c$

$I \propto \theta$ - PMMC

$\theta \propto I^2$ - PMMI

Diff single vs 3phase

Single phase → more power consumption, less efficiency, less cost
3phase → less power consumption, more efficiency, more cost

[Domestic appliances - single phase
Industrial area uses - 3phase]

Power measurement