- **AIM:** Determine the Permeability of magnetic material by Plotting its B-H Curve.

- **APPARATUS REQUIRED:** B-H Curve tracer kit, CRO Patch Cards, Trace Pape magnetic materials : Nail, HackSaw blade, Ferrite Rod, Steel rod.

- **THEORY:**

The log or delog of a magnetic material known commonly as magnetic Hysteresis relate to the magnetisation properties of a material by which it Firstly becomes magnetised and then de-magnetised.

We know that the magnetic flux generated by an electro-magnetic Coil is the amount of magnetic field or lines of Force Produced within a given area and that it is more commonly called "Flux Density" Given the symbol B with the unit of flux density being the Tesla T.

We also know from the Previous tutorious that the magnetic strength of an electromagnetic depends upon the number of turn of the coil we increase either the current or the number of turns we can increase the magnetic field strength symbol H.

The relative permeability symbol μ_r was defined the ratio of the absolute Permeability μ and the permeability of free space μ_0 (vaccum) the relative permeability μ_r is not a constant but a function of the magnetic field giving magnetic flux density as:

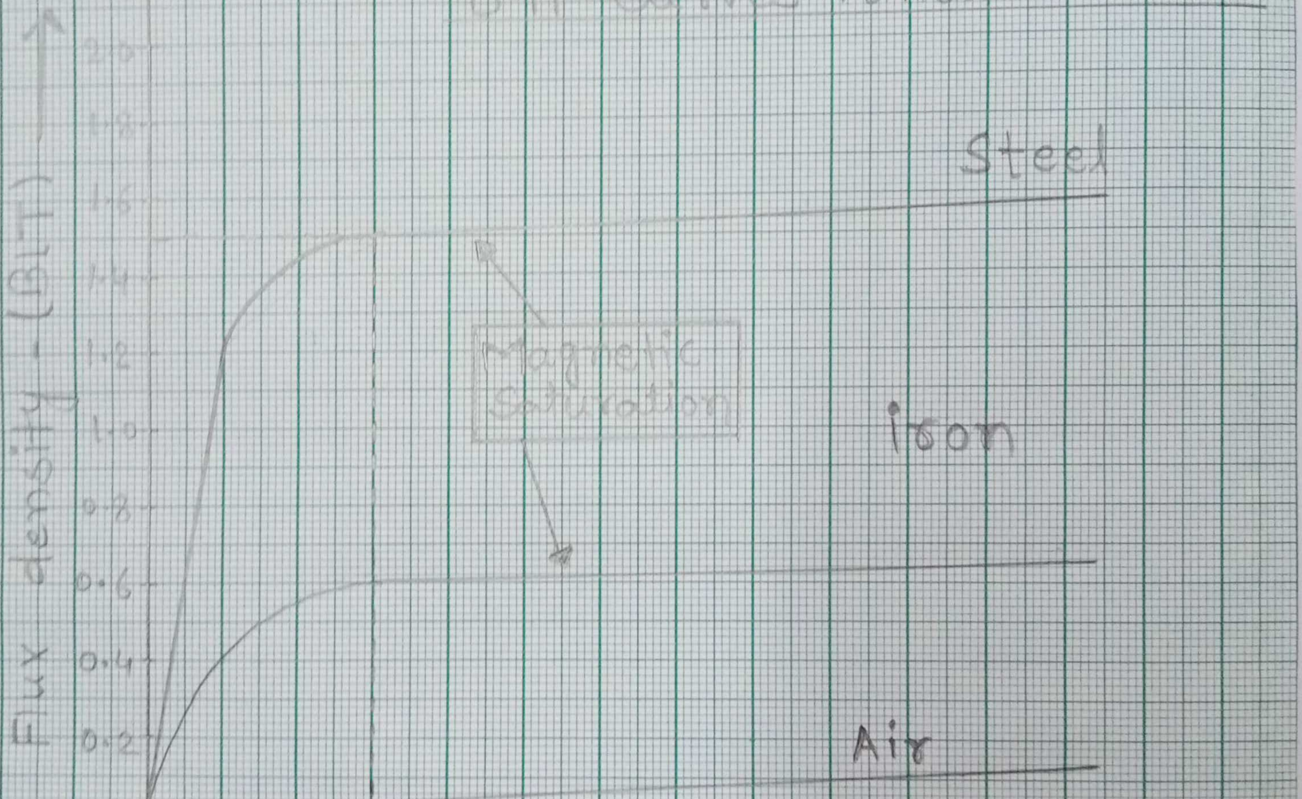
$$B = \mu H$$

Then the magnetic flux density in the material will be increased by a larger factor permeability for the material compard to the magnetic flux density in vaccum $\mu_0 H$ and for an air-cored coil this relationship is given as:

$$B = \frac{\phi}{A} \quad \text{and} \quad \frac{B}{H} = \mu_0$$

By Plotting value of flux density B. against the field strength (H) we can produce a set of curve called magnetisation curve magnetic Hysteresis curve or move commonly B-H curve for each type of core material.

B-H Curves various metels

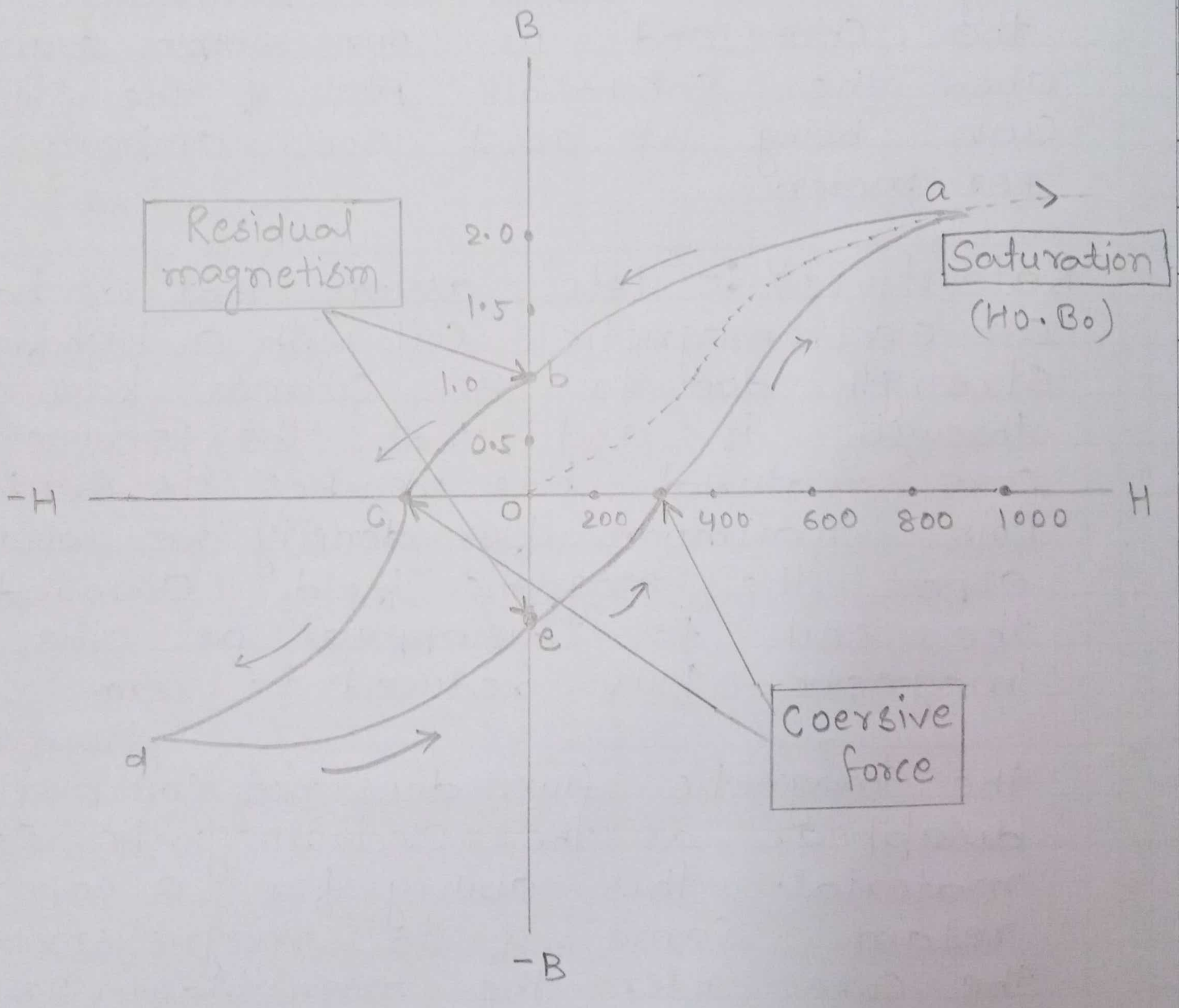


This is be cause there is a limit to the amount of flux density that can be genereted by the core as all the domain in the iron are perfectly aligned. Also known as saturation of the core and in our simple example above the saturation point of the steel curve being at about 3000 ampeare turns per meter.

Retentivity :- Lets assume that we have an electromagnetic coil with a high field strength due to the current folwing through it and that the ferromagnetic core material has reaches its saturation point maximum flux density we would expect the magnetic field arround the coil to disappear as the magnetic flux reduced to zero.

However the magnetic flux does not completly disappear as the electromagnetic core material. this ability for a coil to retain same of its magnetism within the core after the magnetisation process has stopped is called Retentivity or flux density still remaining in the core is called Residual magnetism BR.

Magnetic Hysteresis loop :-

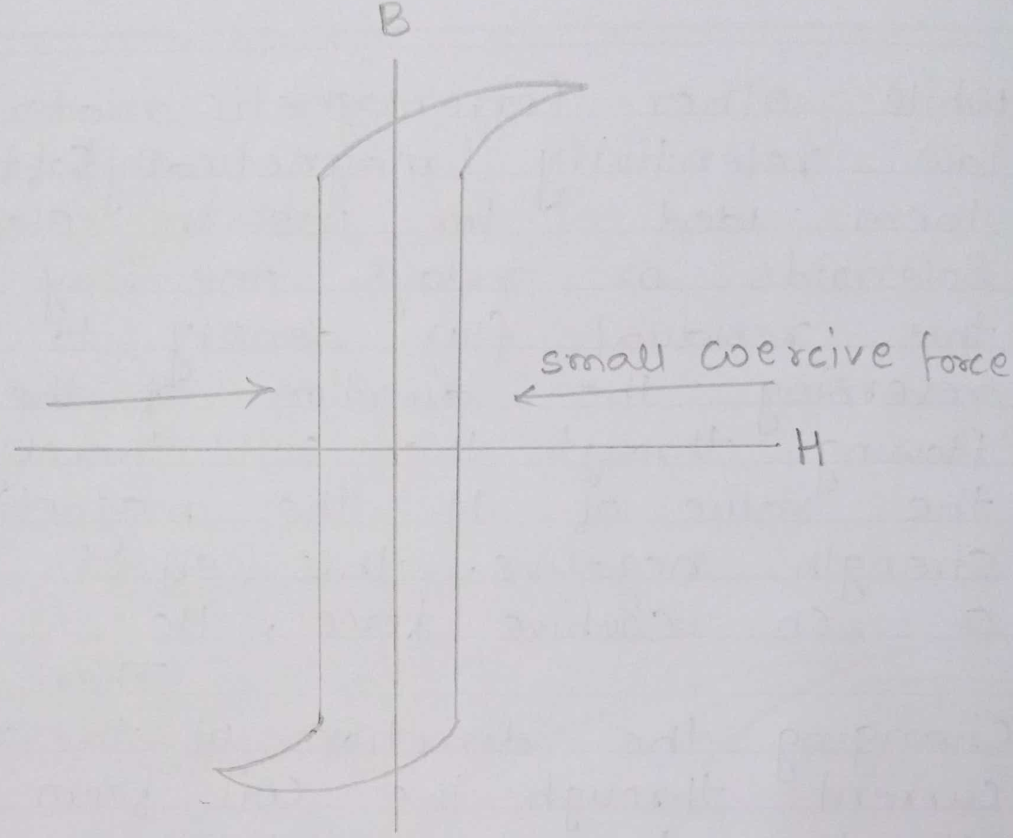


while other ferromagnetic material have law retentivity (magneticallySoft) making them ided for use in electromagnetic Solenoids or relays. one way to reduce this residual flux density to zero is by reversing the direction of the current flowing through the coil thereby making the value of H the magnetic field strength negative. this effect is called a Co Coehive force, Hc.

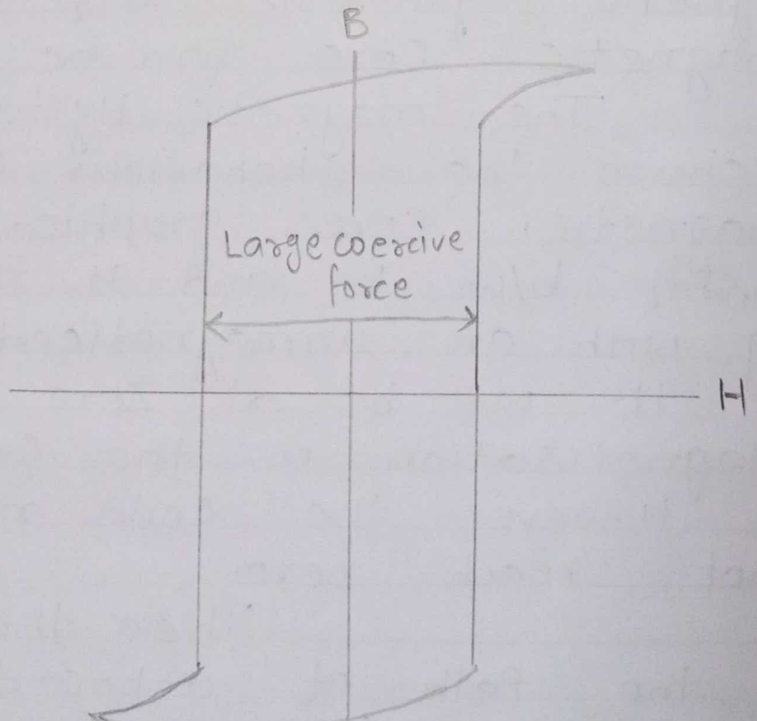
Then by constantaly changing the direction of the magnetising current through the coil from a positive direction to a negative direction as would be the case in an Ac subbly a magnetic Hysteresis loop of the Ferromagnetic core can be Produced.

The magnetic Hysteresis loop above shown the behaviour of the ferromagnetic. core graphically as the relationship b/w B and H in non-linear Starting with an unmagneticed Care both B and H will be at Zero Point on the magnetisation in the coil reduced. Zero However the coils magnetic flux will not reach zero.

Then the B-H curve Follows the Path of a-b-c-d-e-f-a as the magnetism current flowing through



"Soft" Ferromagnetic material



"Hard" ferromagnetic material

The coil alternates b/w a Positive and negative value such as the cycle of an AC voltage. this path is called a magnetic Hysteresis loop.

magnetic Hystresis results in the dissipation of wasted energy. in the from at heat with the energy wasted being in proposition to the area of the magnetic Hysteresis losses will always be a Problem in AC Transformer where the Current is constatly changing direction and thus the magnetic poles in the core will cause losses because the constantly reverse direction.

Rotating coils in DC machines will also incur hysteresis losses they are alternately passing north the South magnetic poles. For example transformer Core it is important that the B-H Hysteresis loop is as small as Possible.

In the tutorial about electromagnetism will look at faraday's law of electromagnetism producing a simple generator.

- **PROCEDURE:**

(a) Connect one terminal of the magnitizing coil to Point C of main unit and the other terminal marked V1 (6 volt ac) connect. H to the Horizontal input ~~input~~ of the CRO and V to vertical input of the CRO operate the CRO in x-y mode.

<b> Connect the IC Prober to the "IC" maked an main unit.

<c> Switch on the kit to get proper loop very the resistance to the maximum value with the help of knob P on the Panel.

<d> Note down x intercept Vx and Y intercept Vy from the graph paper. Calculate the Coecrivity H using relation 1. an retentivity B using relation 2.

<e> Measure the area of the loop with the energy loss = (0.5 × N × VS × SH × area of the loop) R×L unit volume.

(i) Repeat the expt. by verying the ac voltage by connecting coil b/w V_2 (9 volt) and V_3 (12 V).

- ## Precautions:

(a) The specimen should touch the Probe.

(b) If the area of the loop is expressed in cm the sensitivities should be expressed in volt cm. If the area of the loop is expressed.

- **AIM :** Test the PN-Junction diodes using digital multimeter.

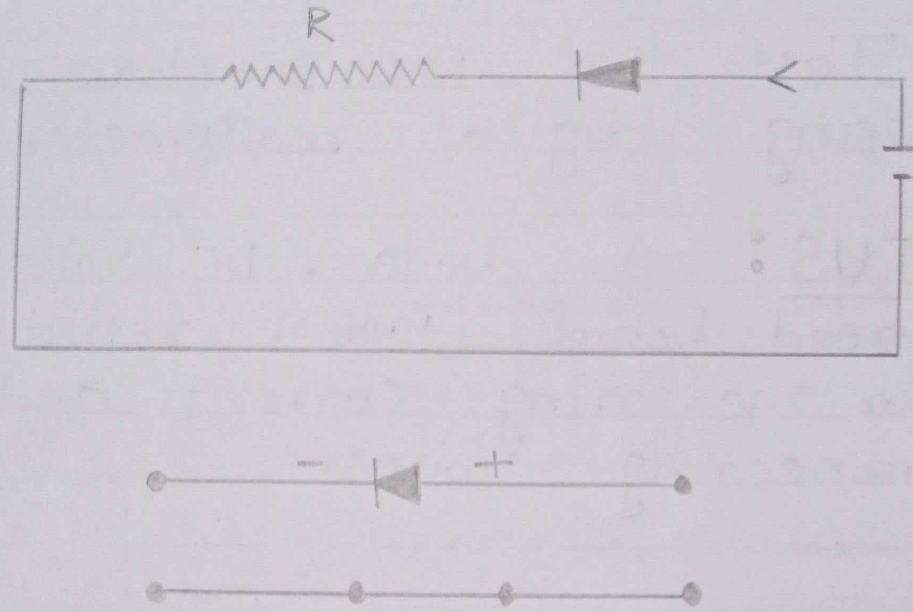
- **APPARATUS :** A diode, DC voltage supplier, Bread board, 1000 Ω resistor, multimeter for measuring current and voltage, Connecting wires.

- **THEORY :**

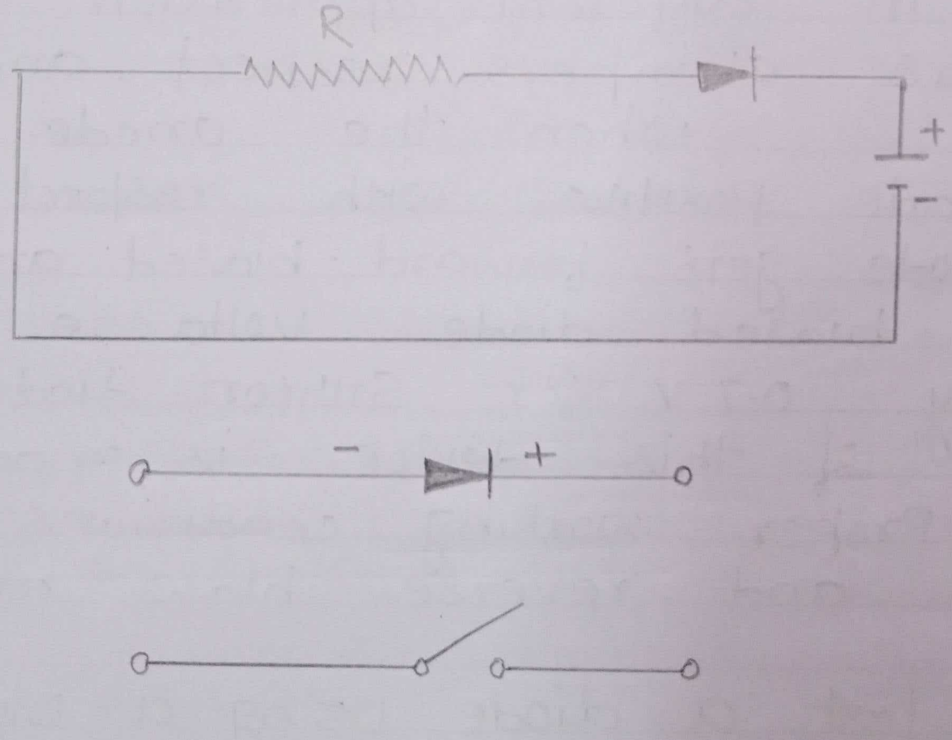
The diode is a two terminal semiconductor device that allow the current only in o e direction. These are found in different application like rectifiers clampers respect and so on.

when the anode terminal is made positive with respect to cathode, the diode gets forward-biased and the forward-biased diode volta e drop is typically 0.7 V for Sillicon diode. the testing of this device is made to know its proper working conditions in forward and reverse biase mode.

How to test a diode using a Digital multimeter :— The diode testing using a digital multimeter (DMM) can be carried in two ways because there are two modes available in DMM



In forward biased mode



In Reverse biased mode

to check the diode. these modes are diode and ohmmeter mode.

★. Identify the terminal anode and cathode of the diode.

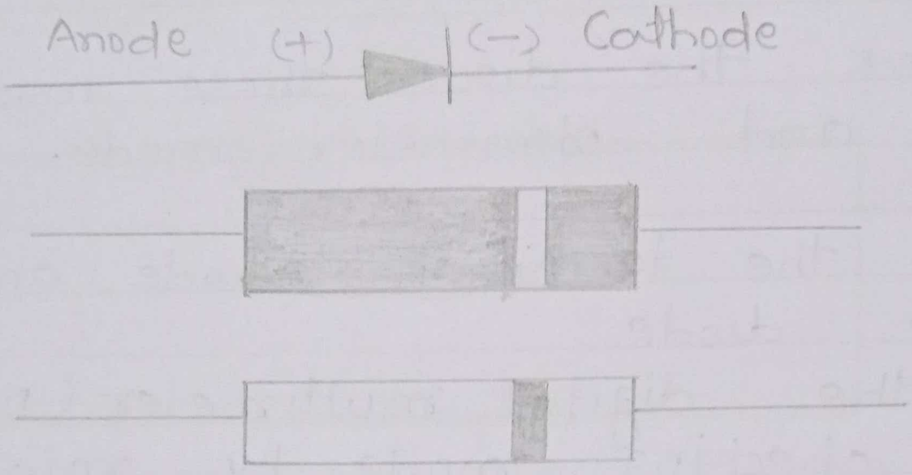
★. Keep the digital multimeter (DMM) in diode checking mode by rotating the central knob to the lace where the diode symbol is indicated. In this mode multimeter is capable to supply a current of 2mA approximately between the test leads.

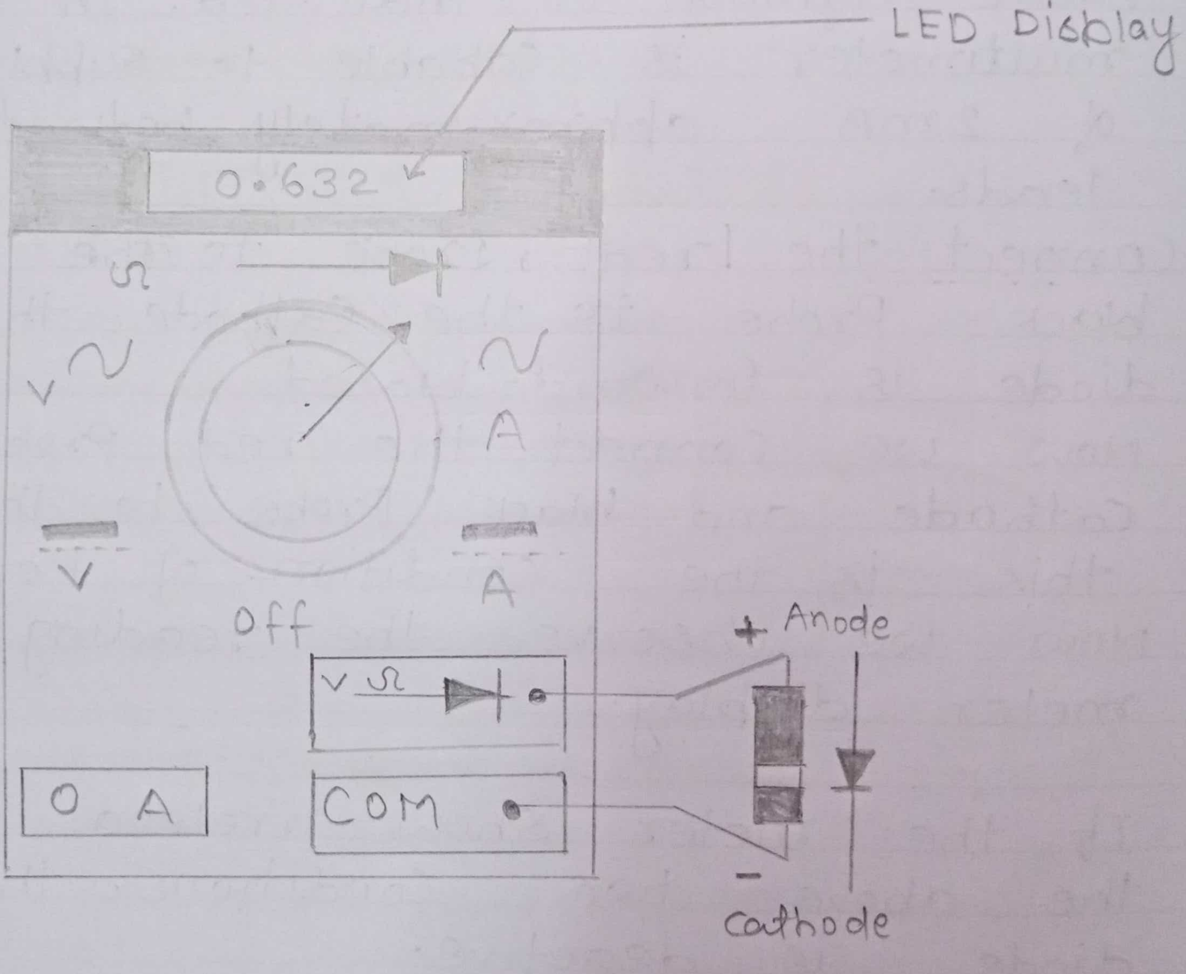
★ Connect the red probe to the anode and black probe to the cathode. this means diode is forward-biased.

★. Now we connect the red probe to the cathode and black probe to the anode this is the condition of Reverse biased.

★. Now we observe the reading on the meter display.

If the meter show irreleva t value to the above two conditions, then the diode is deactive.
The diode defect can be either open or short open diode means diode behaves as an a pen switch in both reverse and forward-biased conditions so noncurrent flows through the diode





Diode mode testing procedure

Therefore the meter will indicate OL in both reverse and forward-biased conditions.

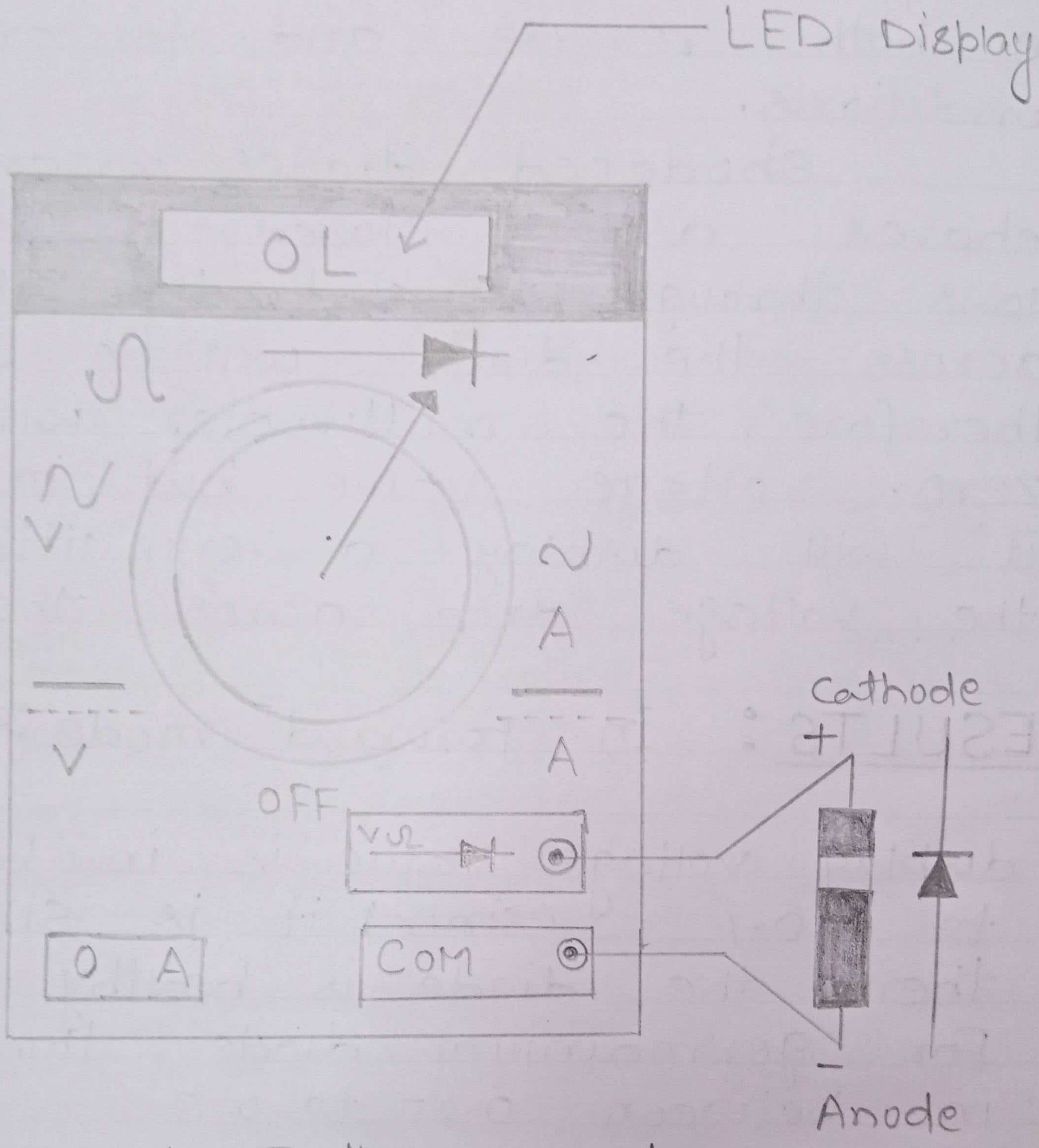
Shortened diodes means diode behaves as a closed Swith so current flows through it and the voltage drop across the diode will be s zero. therefore, the multimeter will indicate zero. voltage value but in same case it will disblay a very little voltage as the voltage drop across the diode.

- **RESULTS:** In forward mode:-

If the display voltage value is in between 0.6 to 0.7 (since) it is silicon diode) then the diode is healthy and perfect. For germainium diode this value is in between 0.25 to 0.5.

In Reverse biased mode:-

In the reverse biased mode condition of the diode where no current flows through it. Hence the meter sould read OL (which is equivalent to open circuit) If diode is healthy.



Diode mode Testing Procedure

- **AIM:** Connect single phase transformer and measure input and output Quantities.

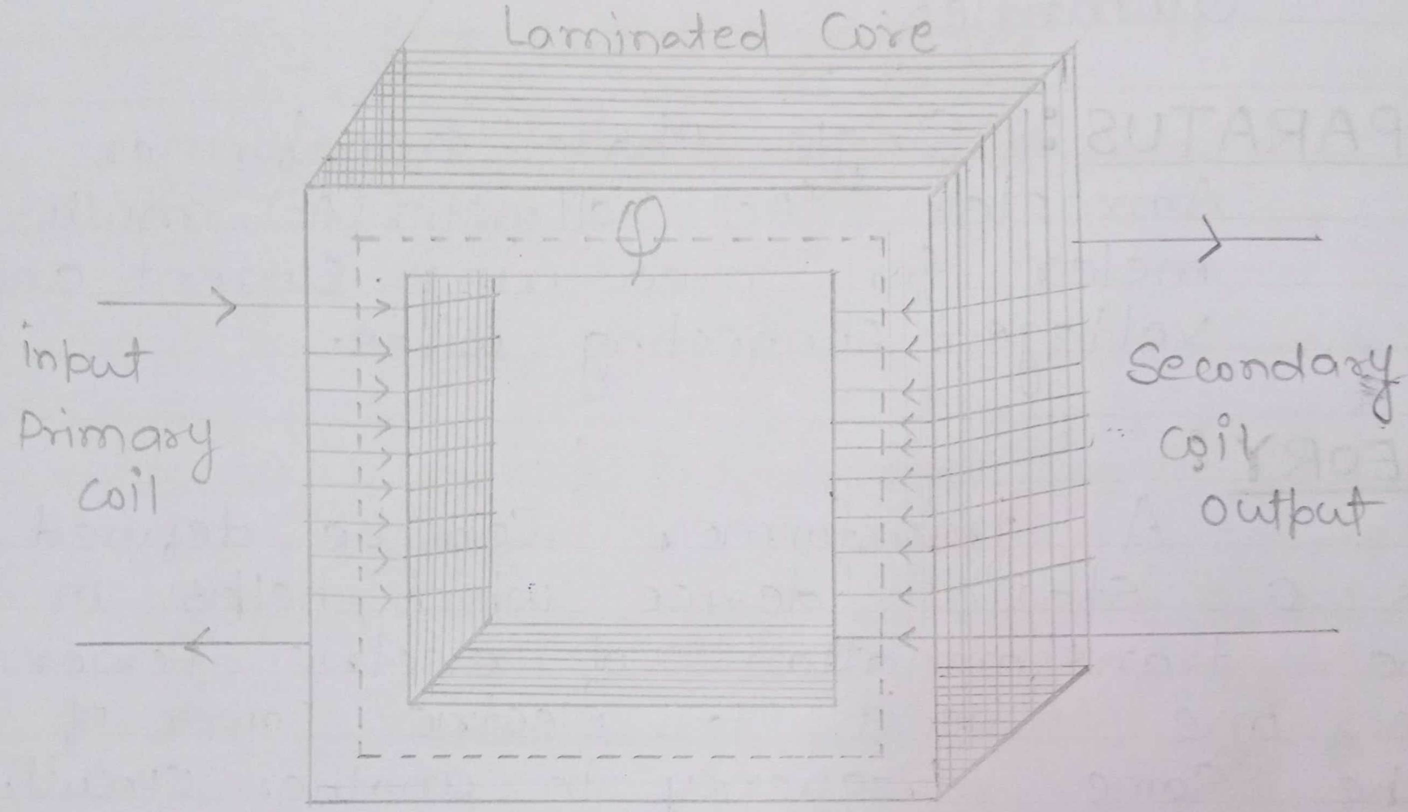
- **APPARATUS:** Single Phase transformer Ammeter (AC) voltmeter (AC), multi-meter for measuring current and voltage connecting wires.

- **THEORY:**

A transformer can be defined as a static device which helps in the transformation of electric power in one circuit to electric power of the same frequency in another circuit. the voltage can be raised or lowered in a circuit but with a proportional increase or decrease in the current ratings. In this article we will be learnings about Transformer basics and working principle.

The main Principle of operation of a transformer is mutual inductance between two circuits which is liked through a Path of reluctance. which is liked by a common magnetic flux. A basic transformer consist of two coils that

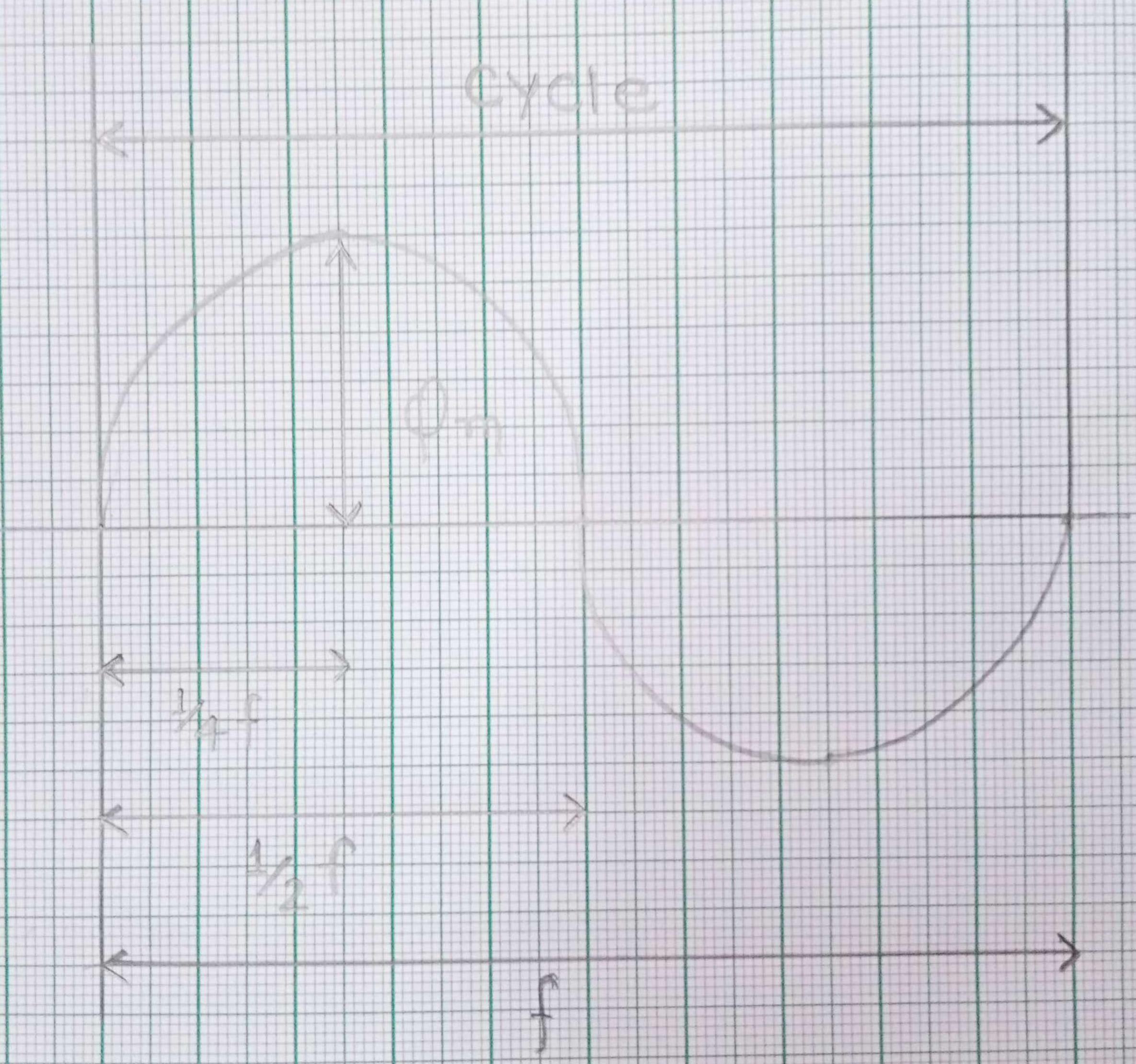
Transformer working



are electrically seprate and inductive but are magnetically linked through a path reluctance. the working principle of the transformer can be understood form the figure below.

As shown above the electrical transformer has primary and secondary windings. The core laminations are joined in the form of strips in between the strips you can see that there are some narrow gaps right through the cross-section of the core these staggered joints are said to be imbricated both the coils have high mutual inductance. A mutual electro-motive force is induced in the transformer from the alternating flux that is set up in the laminated core due to the coil that is connected to a source of alternating voltage most of the alternating flux developed by this coil is linked with the other coil and thus produces the mutual induced electro-motive force. the so produced electro-motive force can be explained with the help of faraday's laws of electromagnetic induction as.

Transformer Emf Equation



Transformer Construction :-

For the Simple Construction of a transformer you must need two coils having mutual inductance and a laminated steel Core. the two coils are insulated from each other and from the steel Core. the device will also need some suitable Container for the assembled Core and windings a medium with which the Core and its windings form its Container Can be insulated.

In order to insulate and to bring out the terminal of the winding from the tank apt pushing that are made from either porcelain or Capacitor type must be used.

IdentifY the transformer inputs and output. This is its electrical input. the second circuit receving power from the transformer is connected to the transformer secondry or the output. the voltage being supplies to the primary should be labeled both on the transformer and the Schematic.

Date

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- **RESULT :**

Input and output power.

i) Electrical power is calculated by multiplying voltage (in volts) by current (in amps).

ii) If a transformer is 100 % efficient then the input power will equal the output power.......

iii) V_P is input (primary) voltage

iv) I_P is input (primary) current

v) V_S is output (secondary) voltage

vi) I_S is output (secondary) current.

Teacher's Signature

- **AIM:** Make Star and Delta Connection in induction motor starters and measure the line and phase value.

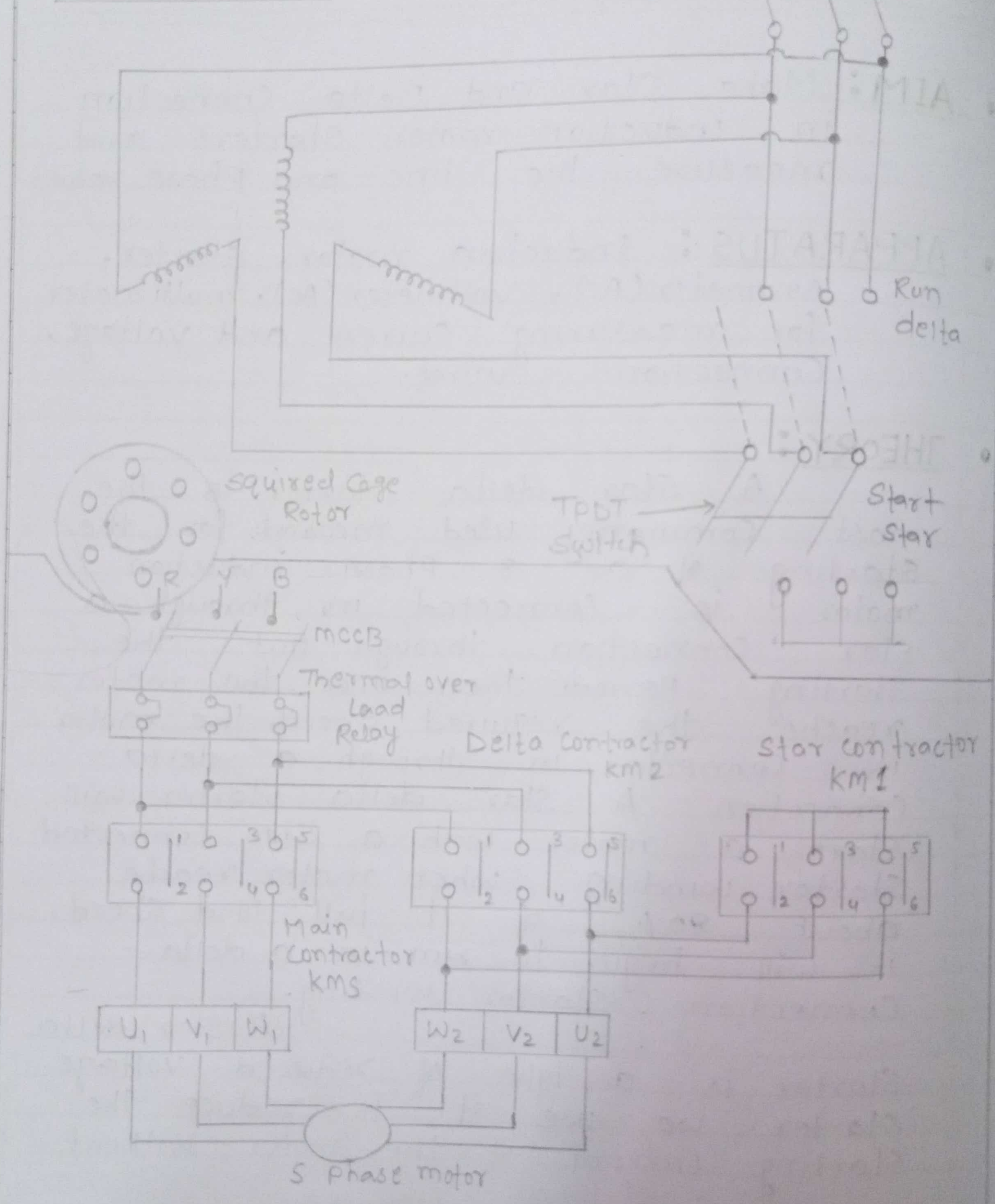
- **APPARATUS:** Induction motor, Starter, Ammeter (AC), Voltmeter (AC), multimeter for measuring current and voltage, Connection wires.

- **THEORY:**

A Star delta starter is the most commonly used method for the starting of a 3 Phase induction motor is connected in through a star connection through out the starting period. then once the motor reache the required speed, the motor is connected in through a delta connection. A star delta starter will start a motor with a star connected startor winding when motor reache about 80% of it full load speed, it will begin to run in a delta connection startor winding.

A star delta starter is a type of reduced voltage starter. we use it to reduce the starting current of the motor without

Electrical HV



Using any external device or apparatus. this is a big advantage of the star delta starter as it typically has around 1/3 of the inrush current compared to a DOL starter. The starter mainly consists of a TPDP switch which stands for tripple pole double throw switch. this switch change stator winding from star delta. During starting condition stator winding is connected in the from star. ~~delta. During starting~~ Now we shall see how a star delta starter reduced the starting current of a three - phase induction motor.

For that let us consider,

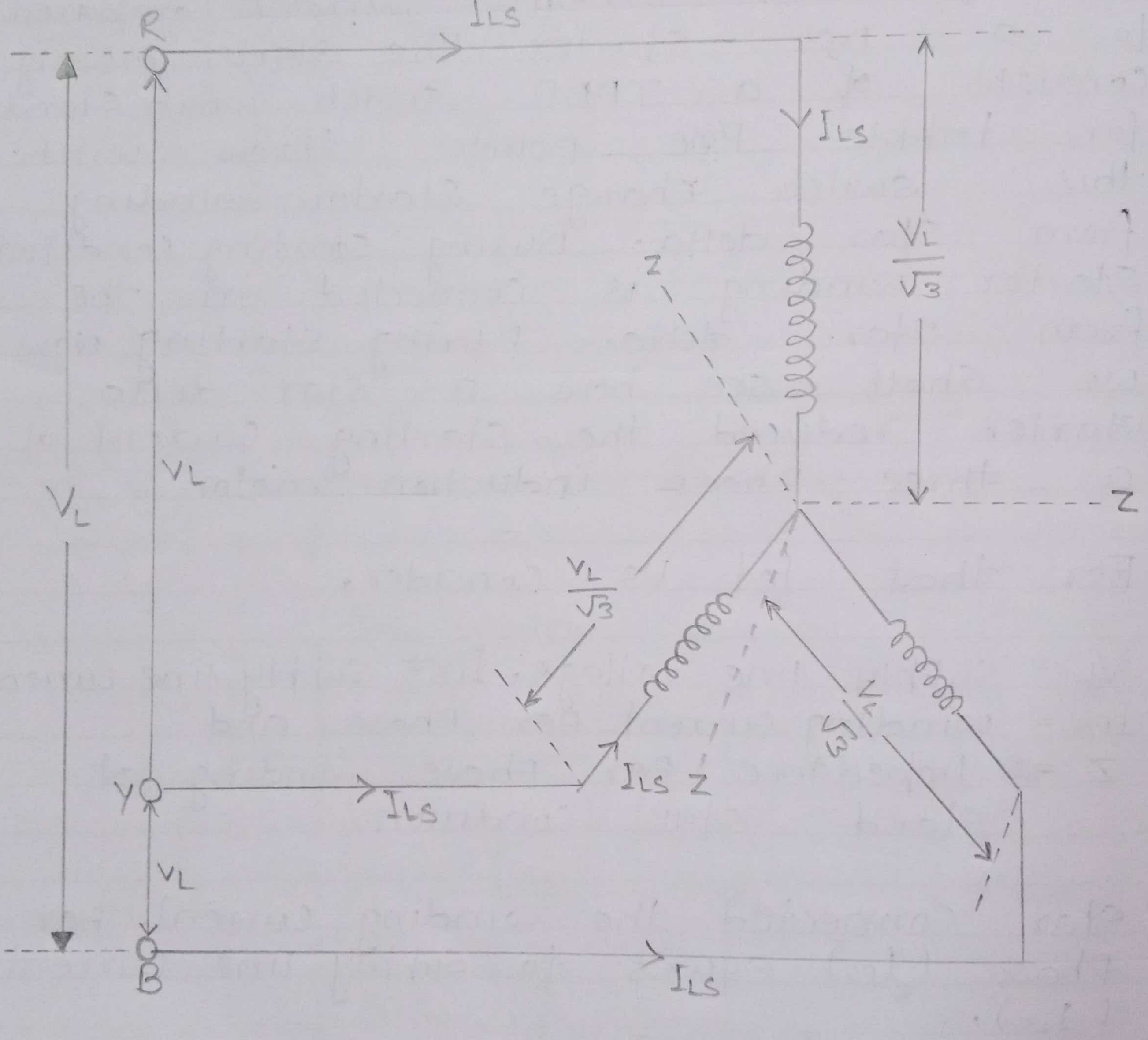
V_L = supply line voltage, I_{LS} = supply line current
I_{PS} = winding current per phase and
Z = Impedance per phase winding at stand still condition.

Star connected the winding current per phase (I_{PS}) equals to supply line current (I_{LS}).

$$I_{PS} = I_{LS}$$

As the winding is star connected the voltage across each phase

Star Connected



at the winding is

$$\frac{V_L}{\sqrt{3}}$$

Hence, the winding current per phase is

$$I_{PS} = \frac{V_L}{\sqrt{3}Z}$$

since here the winding current per phase I_{PS} equal to the supply line current (I_{LS}) we can write

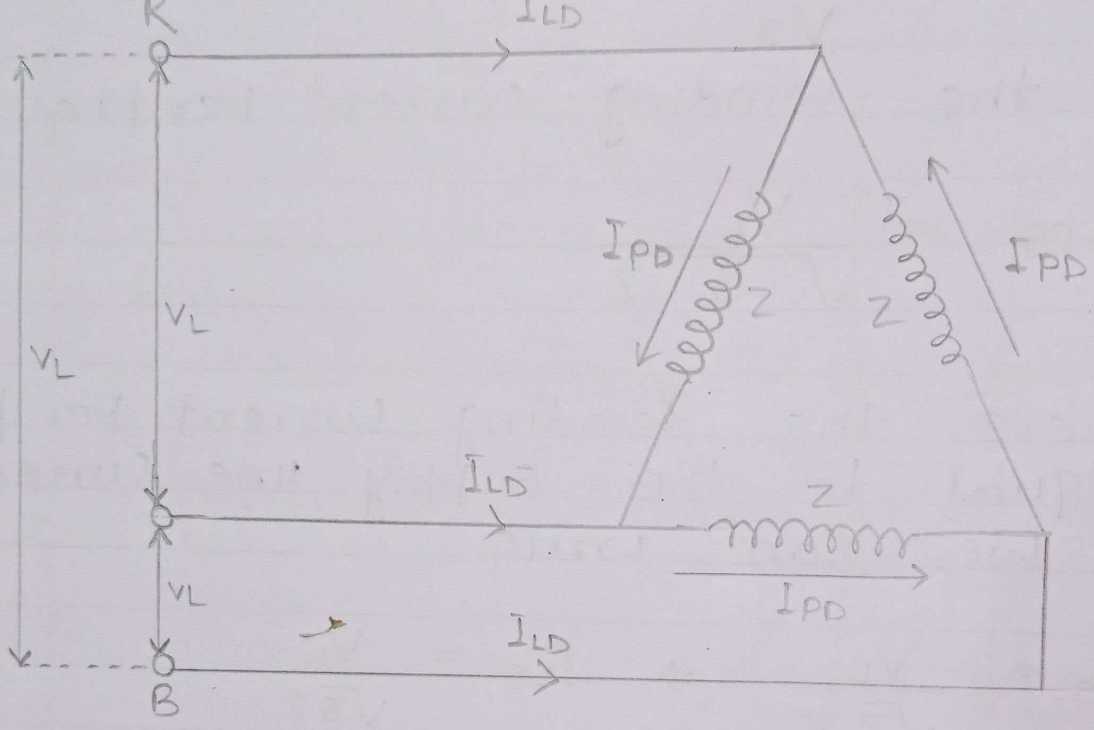
$$I_{PS} = \frac{V_L}{\sqrt{3}Z} \Rightarrow I_{LS} = \frac{V_L}{\sqrt{3}Z}$$

Now, let us consider sitution where the motor gets started with delta connected starter winding from same three. Phase supply points

I_{LD} = Supply line current and I_{PD} = winding current per phase and Z = Impedence per phase winding at stand still condition.

As the winding is delta connection supply line current (I_{LD}) is root three times of the winding current per places (I_{PD})

Delta Connected



$$I_{LD} = \sqrt{3}\, I_{PD}$$

As the winding is delta connection the voltage across each phase of the winding is V_L.

Hence, the winding current per phase is

$$I_{PD} = \frac{V_L}{Z}$$

Now, we can write,

$$I_{LD} = \sqrt{3}\, I_{PD} = \frac{\sqrt{3}\, V_L}{Z}$$

Now, by comparing supply line current drawn by an induction motor with star and delta connected winding we get.

$$\frac{I_{LD}}{I_{LS}} = \frac{\frac{\sqrt{3}\, V_L}{Z}}{\frac{V_L}{\sqrt{3}\, Z}} = 3$$

$$\Rightarrow I_{LS} = \frac{1}{3} I_{LD}$$

Thus we can say the starting current from the mains in case of star delta is one third of direct switching in the delta. Again we know that the starting torque of an induction motor is proportional to the square of the voltage applied to the winding Per phase

$$\frac{\text{Starting torque in star connected starter winding Motor}}{\text{Starting torque in delta connected starter winding Motor}} = \frac{1}{3}$$

The Star equation shows that star delta starter reduces the Starting torque to one third of that Produced by DOL Starter the Star-delta is equivalent to an auto transformer with a 57.7% tapping.

Line voltage and Phase voltage :- Line voltage in a three-Phase system is the potential difference between any two line winding Coil. If R, Y and B are the difference between R and Y, Y and B. B and R, denoted by V Phase = $V_R = V_X = V_B$ Voltage in blue.

- **AIM:** To verify the laws of combination of resistence (series and Parallel) using a metre bridge.

- **APPRATUS:** A metre bridge, a sensitive galvenometer, two different resistances (Carbon or wire-wound resistors), a resistance box, a Jockey, rheostat, a Plug key, a cell or battery eliminator, thick connecting wires and a piece of sand paper.

- **THEORY:**

when two resistance R_1 and R_2 are connected in series the resistance of the combination R_s is given by i.e,

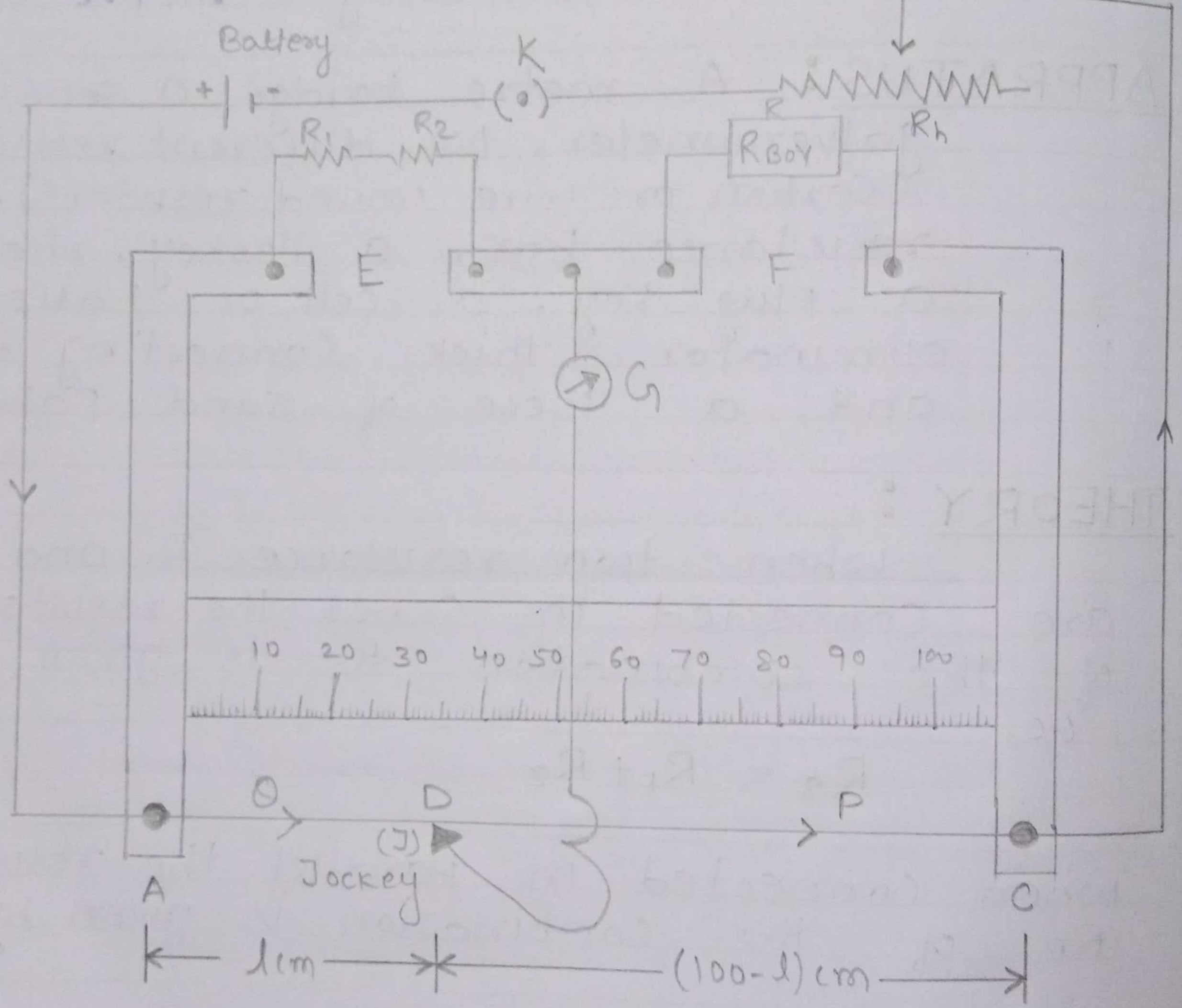
$$R_s = R_1 + R_2$$

when connected in parallel the resistance R_P of the combination is given by

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

- **PROCEDURE:**

(a) Set up the circuit as Series combination.



Resistance R_1 and R_2 Connected of a series to one arm of a metre bridge.

(b) Tighten all pluge in the resistance box (RBox) by rotating and pressing each plug to ensure that all plug make good electrical constant. Clean the ends of connecting wires using a sand paper before making the connections.

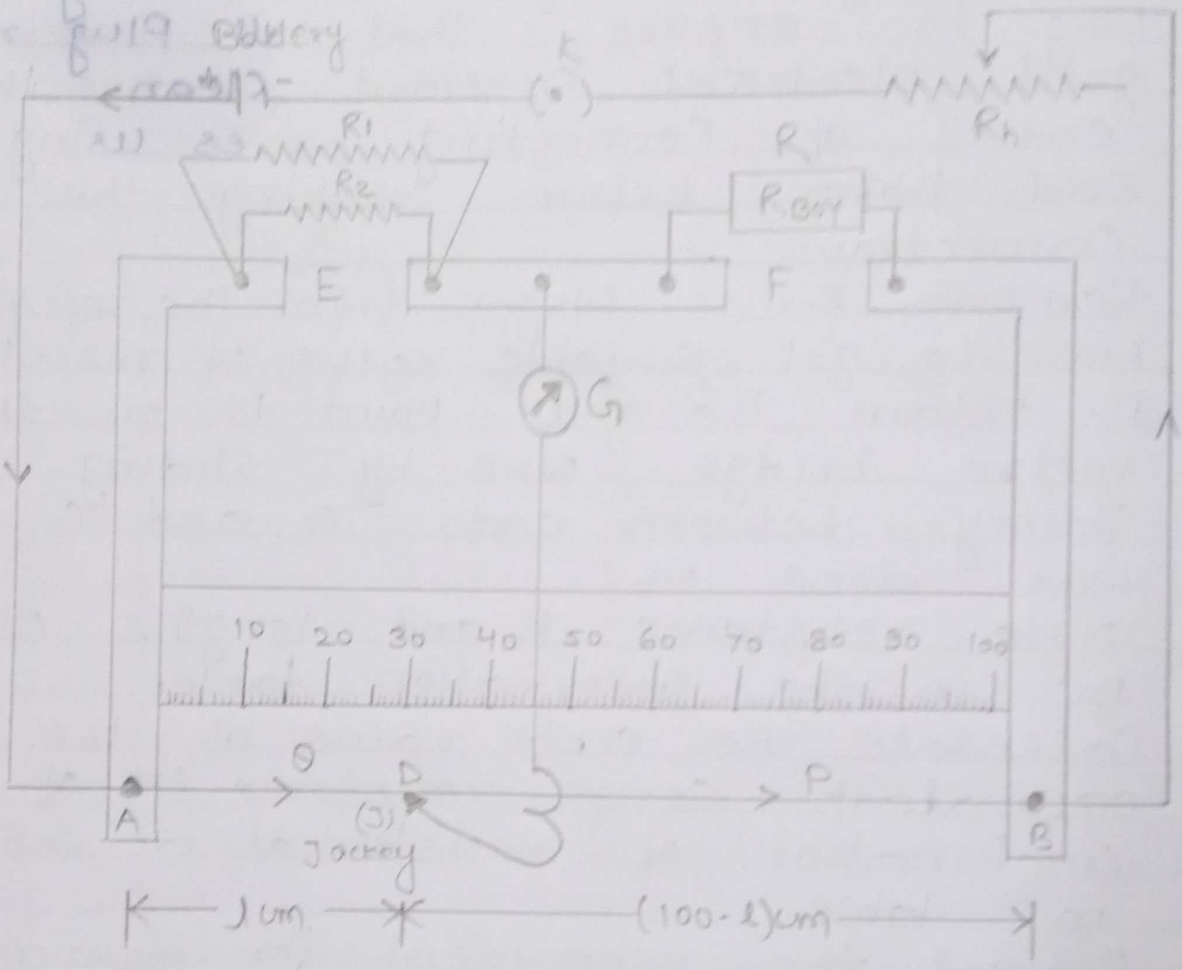
(c) Remove some pluges from the resistance box to get suitable value of resistance R. obtain the null point D on the metre bridge wire by sliding the Jockey between ends A and C as was done in.

(d) Note resistance R and lengths AD and DC in the observation table.

(e) Calculate the expt. value of the equivalent series resistance (X) of combination of resistances as shown in table.

(f) Repeat the experiment for four more value of resistance R. obtain the mean value of unknown resistance.

(g) Repeat step-2 2-6 by connecting resistance R_1 and R_2 in parallel as shown and calculate the experimental value of the equivalent.



Resistance R_1 and R_2 connected in parallel to one arm of a metre bridge

• CALCULATION:

① The theoryticaly expected value of the series combination of resistance is
$R_s = R_1 + R_2$.

(ii) Theoryti cally expected value of the Parallel combination of resistance is.

$$R_p = \frac{R_1 \cdot R_2}{R_1 + R_2}$$

Error :-

In estimating errors, we have Present that error in R is zero i.e, R is expected to be the Some as indicated on resistance box.

$$\frac{\Delta R_s}{R_s} = \frac{\Delta l}{l} + \frac{\Delta l'}{l'}$$

where R_s, l and l' value are to be taken from the observation table and Δl, $\Delta l'$ indicate the least count of the measuring scale on the metre bridge.
i.e,

$$\Delta R_s = R_s \left[\frac{\Delta l}{l} + \frac{\Delta l'}{l'}\right]$$

similarly, $\Delta R_p = R_p\left[\frac{\Delta l}{l} + \frac{\Delta l'}{l'}\right]$

maximum of the five values of ΔR_s and ΔR_p should be reported of the estimation in error the be error will be mini. it balancing length $l = l'$.

- ## OBSERVATIONS TABLE :

	S. No.	Resistance R(Ω)	Length AD = l (cm)	Length DC = r = (100 - l) (cm)	unknown Resistance x(R_s or R_p) = Rl/l'	ΔR_s or ΔR_p (ohm)
R_1 and R_2 in series R_s	1					
	2					
	⋮					
	5					
					mean R_s	
R_1 and R_2 in Parallel R_p	1					
	2					
	⋮					
	5					
					mean R_p	