

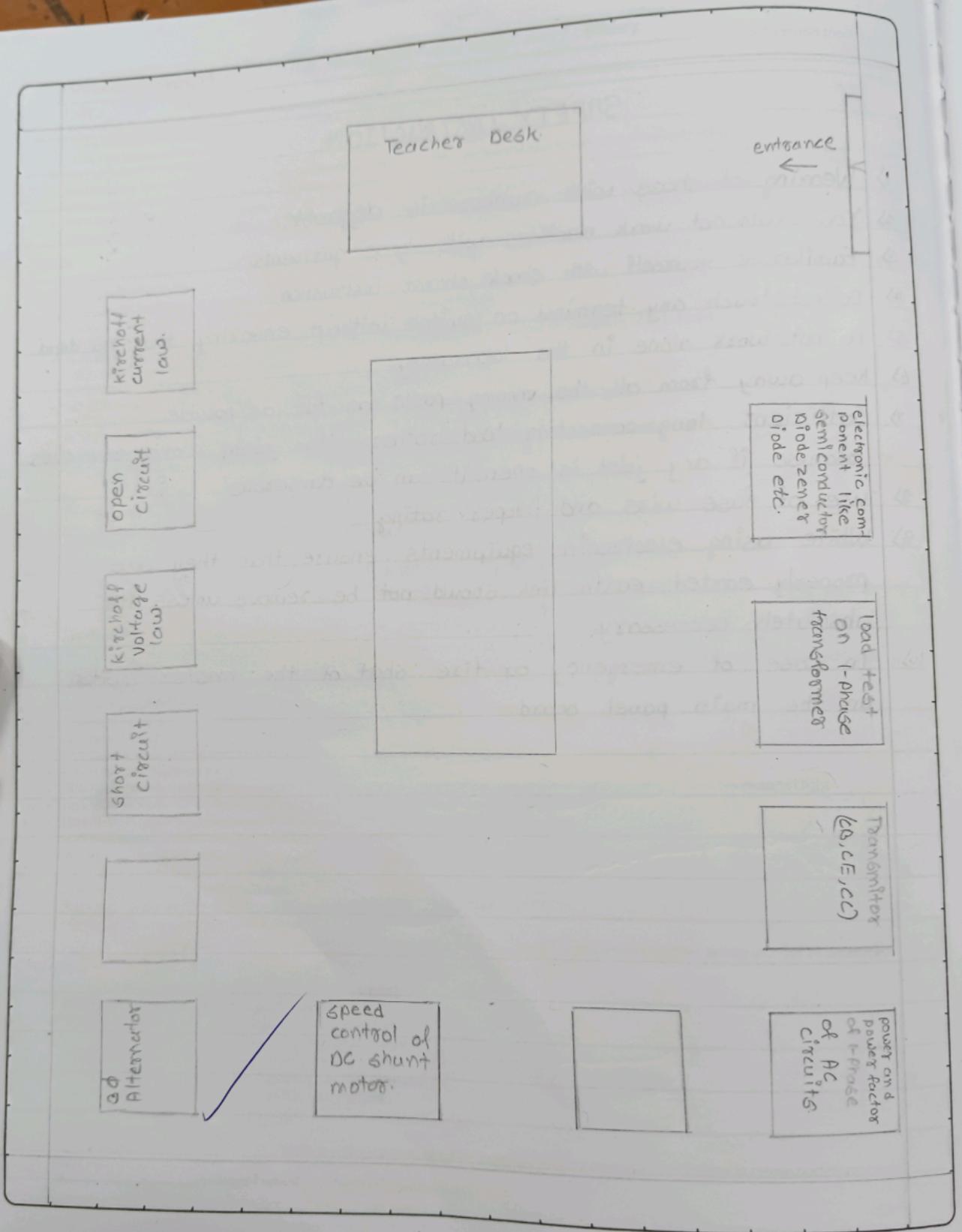
SAFETY INSTRUCTION.

- 1) Wearing of shoes with rubber is desirable.
- 2) You should not work machines with loose garments.
- 3) Familiarise yourself with shock hazard instruction
- 4) Do not touch any terminal or switch without ensuring that its dead.
- 5) Do not work alone in the laboratory.
- 6) Keep away from all the moving parts as far as possible.
- 7) Sufficient long connecting lead rather than joining 2 or 3 small ones because if any joint is open it can be dangerous.
- 8) Use of fuse wire and proper rating.
- 9) While using electronic equipments, ensure that they are properly earthed, earth link should not be removed unless its absolutely necessary.
- 10) In case of emergency or fire, shut off the master switch on the main panel board.

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Teacher's Signature:



LIST OF EXPERIMENTS.

- 1) Verification of Kirchoff's voltage law.
- 2) Verification of Kirchoff's current law.
- 3) Measurement of power and power factor of single phase AC circuits.
- 4) Measurement of resistance of armature winding, shunt field winding and series field winding of dc machine.
- 5) Speed control of DC shunt motor.
- 6) To perform load test on single phase transformer.
- 7) To perform open circuit test on single phase transformer.
- 8) To perform short circuit test on single phase transformer.
- 9) Study of electronic component like semiconductor, diode, zener diode etc.
- 10) Demonstration of Half wave and full wave rectifier.
- 11) To study the transistor and their various configurations. (common base, common emitter, common collector).

Teacher's Signature:

1.  Resistance.

2.  inductor.

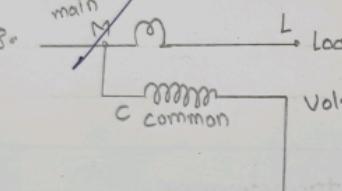
3.  capacitor.

4.  AC source. $MC \rightarrow DC$

5.  DC voltmeter.

6.  DC Ammeter.

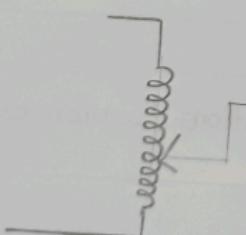
7.  variable resistance.

8.  main
M
L
common
C

Voltage across.

9.  DC Source.

10.  Fuse

11. 

Single phase variac.
(Variable transformer).

Experiment - 1

Observation Table :

S.No.	V ₁	V ₂	V ₃	(V ₂ +V ₃)	% error
1	130	67.5	62.5	130	0
2	140	72.5	65.5	138	1.42
3	150	75	70	145	3.33
4	160	80	75	155	3.12

$$\text{Mean \% error} = \frac{0+1.42+3.33+3.12}{4} = 1.96\%$$

Aim : To verify Kirchhoff's Voltage Law
Apparatus Required :

S.No	Instrument	Type	Range	Quantity
1	Voltmeter	MI	0-200V	1
2	Voltmeter	MI	0-150V	2
3	Rheostat	Single tube	45Ω, 5A	3

Theory : Kirchoff's voltage law state that at any closed active circuit the algebraic sum of voltage drop along the circuit in a specific direction is equal to total emf acting in circuit.

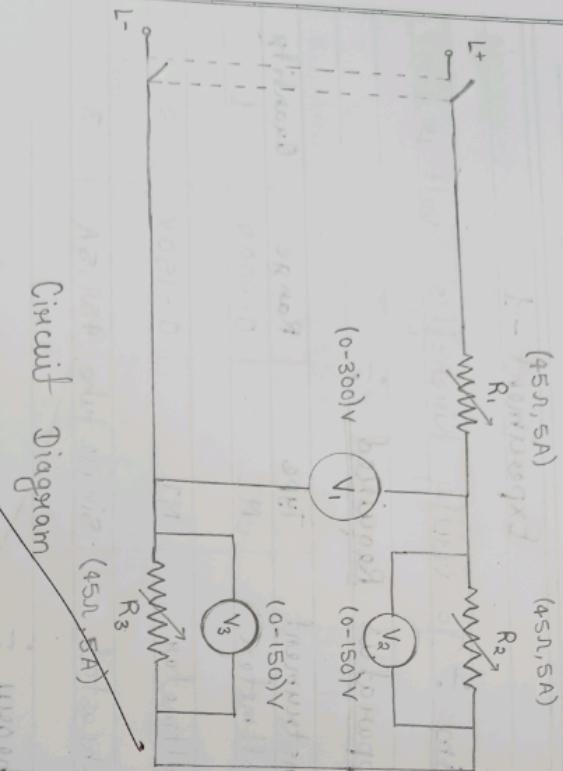
Formula used :

$$\% \text{ error} = \frac{V_1 - V_2 + V_3}{V_1} \times 100$$

Result : Kirchoff's voltage law is performed and hence it is proved that mean % error comes out to be 1.96%.

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Teacher's Signature.

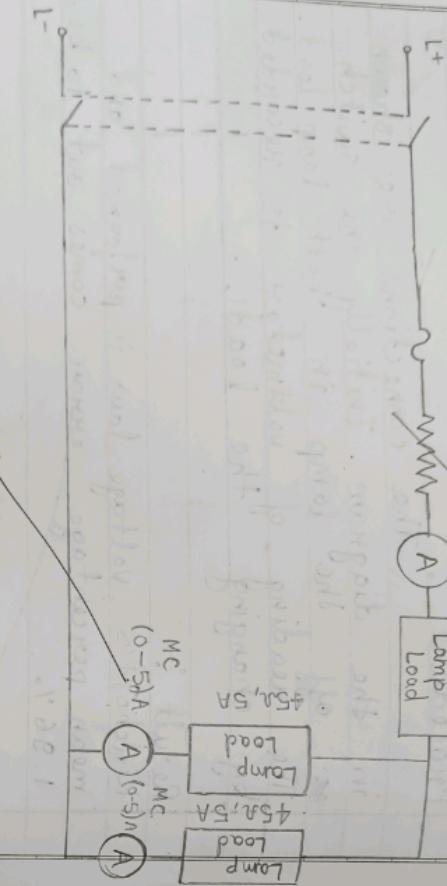


Circuit Diagram

Procedure :- The connections are shown in the diagram. Initially the switch is off the lamp in both lamp load. The reading of voltmeters is recorded by changing the load.

Result :- Kirchhoff's voltage law is performed and mean percentage error comes out to be 1.96% .

(45Ω, 5A) MC (0-10) A 45Ω, 5A



Aim : verification of Kirchoff's current law
Apparatus Required :

S.No	Name	Type	Range	Quantity
1.	Ammeter	MC	0-10 amp	1
2.	Ammeter	MC	0-5 amp	2
3.	Load	Rheostat / Lamp load	45Ω, 5A	3

Theory :

KCL - It states that at any junction in circuit of active network, the sum of current entering will be equal to the current leaving.

Procedure :

Connections are made as shown in the circuit diagram keeping the resistance of values such that max. rated value is not exceeded. The reading of

observation Table

S. No.	I_1 (A)	I_2 (A)	I_3 (A)	$I_2 + I_3$ (A)	Error
1.	1.8	0.6	1.2	1.8	0.0
2.	1.4	0.7	0.7	1.4	0.0
3.	2.2	1	1.2	2.2	0.0
4.	3.4	1.2	2.0	3.2	5.8

$$\text{mean \% error} = \frac{0+0+0+5.8}{4}$$

$$= 1.45\%$$

Ammeter are recorded by varying the resistance R_2 & R_3 . Different sets of reading of ammeter are taken.

Result :

After performing Kirchhoff's law 1.45 % error is observed.

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Set No.	R_2 (ohm)	R_3 (ohm)	I_1 (A)	I_2 (A)	I_3 (A)	Total Current (A)
1	1000	1000	2.2	0.7	1.2	4.1
2	1000	1000	2.2	0.7	1.2	4.1
3	1000	1000	2.2	0.7	1.2	4.1
4	1000	1000	2.2	0.7	1.2	4.1
5	1000	1000	2.2	0.7	1.2	4.1
6	1000	1000	2.2	0.7	1.2	4.1
7	1000	1000	2.2	0.7	1.2	4.1
8	1000	1000	2.2	0.7	1.2	4.1
9	1000	1000	2.2	0.7	1.2	4.1
10	1000	1000	2.2	0.7	1.2	4.1

Date:

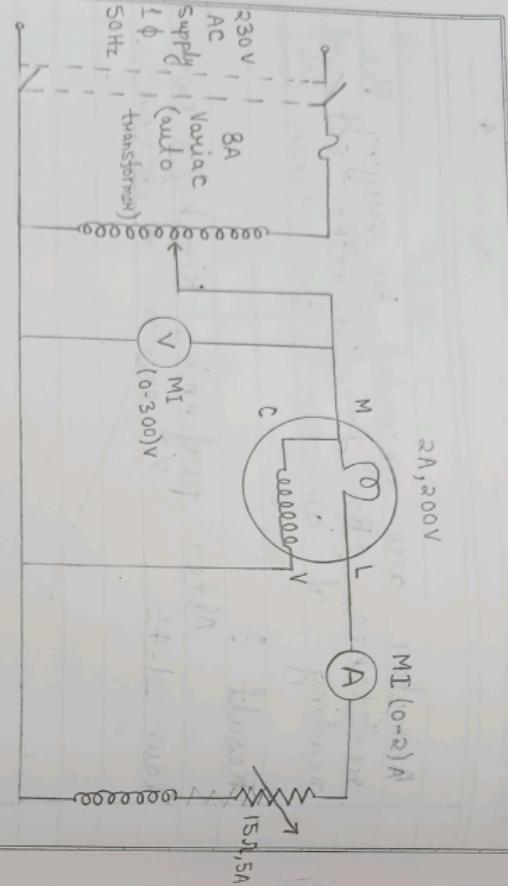
Teacher's Signature:

Aim : Measurement of power and power factor of single phase AC circuit.

Apparatus Required :

S.No	Name	Type	Range	Quantity
1.	Voltmeter	MT	(0-300) V	1
2.	Wattmeter		2A, 200V	1
3.	Ammeter	MT	(0-2) A	1
4.	Variac		230V, (0-270) A	1
5.	Rheostat		15Ω, 5A	1

Circuit diagram to measure Power and power factor of AC circuit



Theory : In AC circuit, both voltage and current vary sinusoidally in time and not necessarily in phase. The instantaneous voltage and instantaneous current also vary with time. In this case, the average power is given by $P = VI \cos \phi$ where V, I are the rms value of voltage & current respectively and ϕ is the angle of phase difference b/w $V & I$.

The power factor is the ratio of real and apparent power (VI) and depends on the relative value of R, L and C in RLC circuit.

Barograph analogy

The power is usually measured by means of dynamometer type voltmeter. In this type, there are 2 coils, the current coil & the pressure coil. The current coil is fixed in two parts. Pressure coil is the moving coil that moves freely in the field produced by current coil is directly proportional to current in the ~~circuit~~. The current in pressure coil is current voltage. The torque on moving coil, which is produced by the interaction of current coil is proportional to the average value of power in circuit.

Procedure

1. Make connections as shown in circuit diagram the supply is switched in with the setting of auto-transformer preferably around 150 V.

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Teacher's Signature:

S. No.	Voltmeter (V)	Ammeter (A)	Wattmeter (W) x (mF)	Power (VI)	Power factor
1	220	0.9	$4.1 \times 8 = 32.8$	198	0.165
2	230	1.0	$4.6 \times 8 = 36.8$	230	0.160
3	240	1.2	$5.2 \times 8 = 41.6$	288	0.144
4	250	1.4	$5.4 \times 8 = 45.6$	350	0.130

$$\text{Mean Power factor} = \frac{0.165 + 0.160 + 0.144 + 0.130}{4}$$

$$= 0.149$$

Volt - ampere is the product of voltmeter and ammeter reading.

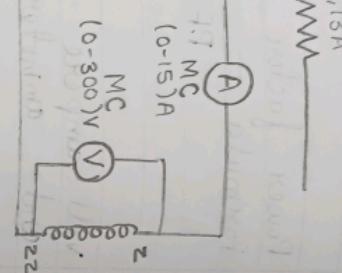
~~The power factor for 1- ϕ AC circuit is 0.449.~~

Date
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Experiment-4

Aim : Measurement of resistance of the armature winding, single field winding and shunt field winding of DC machine.



Measurement of shunt field winding resistance

RPM : 1500 rpm

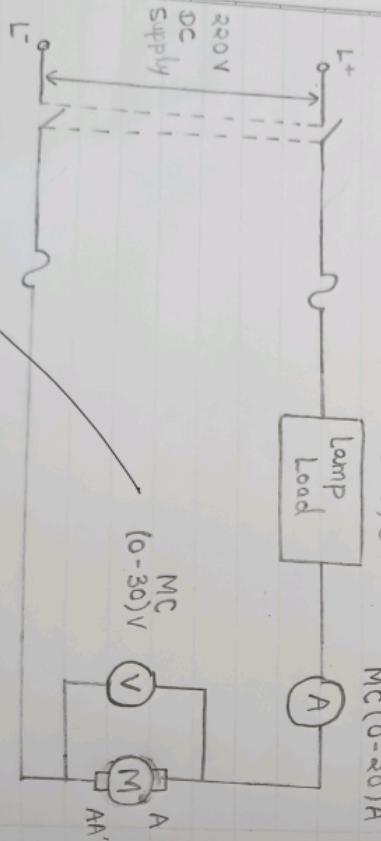
Voltage : 250V

Amperes : 15A

Name plate specification of machine

BHP/kW : 7.5HP

Instruments required



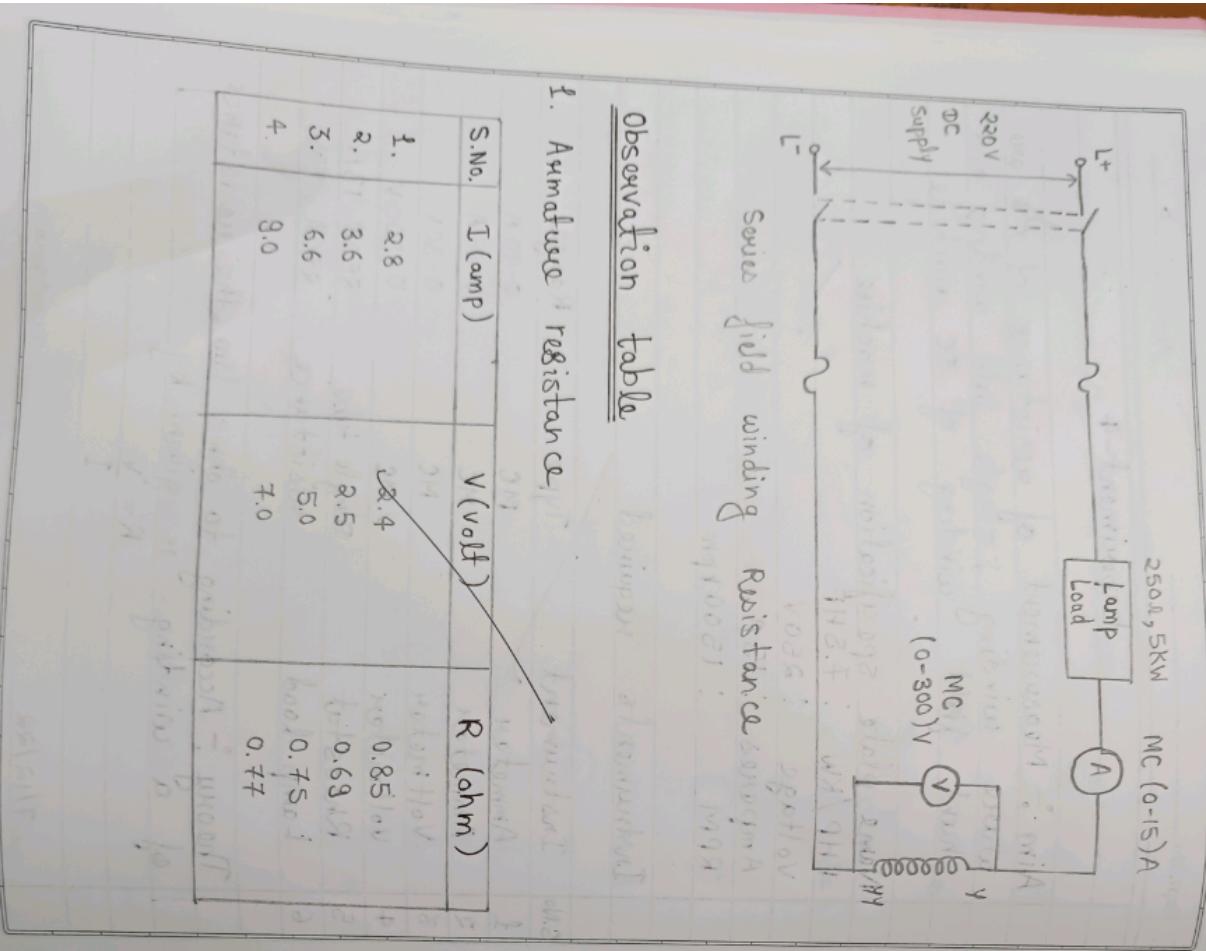
Measurement of armature resistance

Theory : According to ohm's law the resistance of a winding is given by

$$R = \frac{V}{I}$$

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where, V - Voltage drop across the winding
 I - Current through the winding

Procedure :

- Measurement of armature resistance, series field resistance connection are made as shown in figure, the reading of values of various meter is recorded for different values of current flowing through the above winding. The variation in current is obtained with the help of lamp load. The readings are taken up to 125% of the rated current of the machine.

S.No.	I (amp)	V (volt)	R (ohm)
1.	2.8	0.4	0.85
2.	3.6	2.5	0.69
3.	6.6	5.0	0.75
4.	9.0	7.0	0.77

Observation table

According to ohm's law $V = IR$

$$\therefore R = \frac{V}{I}$$

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Teacher's Signature:

2. Series field resistance

S.No.	I (amp)	V (Volt)	R (ohm)
1.	2.8	0.10	0.03
2.	3.6	0.15	0.04
3.	6.8	0.20	0.02
4.	9.2	0.30	0.03

3. Shunt field Resistance

S.No.	I (amp)	V (volt)	R (ohm)
1.	0.8	27	33.7
2.	1.2	33	27.5
3.	1.6	42	26.2
4.	2.0	57	28.5

Calculations:

$$\text{Mean of Armature resistance} = \frac{0.69 + 0.75 + 0.77 + 0.85}{4} = 0.76\Omega$$

$$\text{Mean of series field resistance} = \frac{0.04 + 0.02 + 0.03 + 0.03}{4} = 0.03\Omega$$

$$\text{Mean of shunt field resistance} = \frac{33.7 + 27.5 + 26.2 + 28.5}{4} = 28.9\Omega$$

Also, average resistance = $R_a + \frac{R_y + R_z}{3}$

Conclusions :

The resistance of armature winding is 0.76Ω .
 The resistance of series field winding is 0.03Ω .
 The resistance of shunt field winding is 28.9Ω .

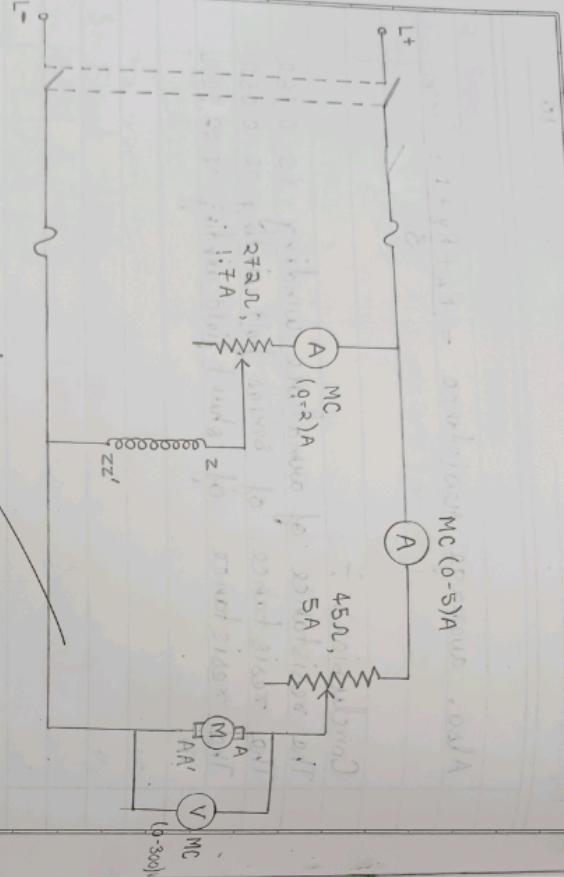
Experiment - 5

Aim : To control the speed of a DC shunt motor using -
 i) Series resistance in the armature circuit
 ii) Series resistance in the field circuit
 iii) Draw the speed v/s voltage and speed v/s field current curve.

Instruments Required :

S.No	Instrument	Type	Range
1	Tachometer	-	0-2000 rpm
2	Rheostat	Single tube	272Ω, 1.7 A
3	Rheostat	Single tube	45Ω, 5 A
4	Voltmeter	MC	0-300 V
5	Ammeter	MC	0-2A, 0-5A

Circuit Diagram



Name plate specification of Machine

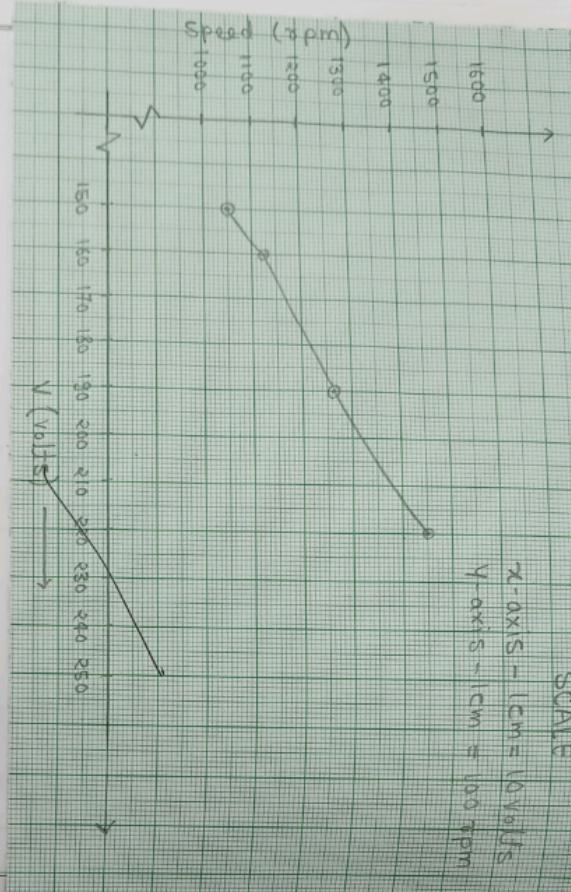
DC Component	Machine
BHP / kW	5HP
Voltage	220V
Amperage	18A
RPM	1500 rpm

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Teacher's Signature.....

SCALE

x-axis = 1cm = 0.01 Volts
y-axis = 1cm = 100 rpm



Speed vs Voltage Curve

Relation for DC motor is given -

$$V_t = E_b + I_a R_a \quad \text{--- (1)}$$

Here,

V_t = Supply voltage, Volts

E_b = Back emf, Volts

I_a = Current, Amperes

R_a = Resistance, ohms

Back emf is given by

$$E_b = \frac{\Phi N Z}{60 A} \quad \text{--- (2)}$$

where, Φ = useful flux per pole

Z = Total number of turns in conductor

N = Speed in rpm

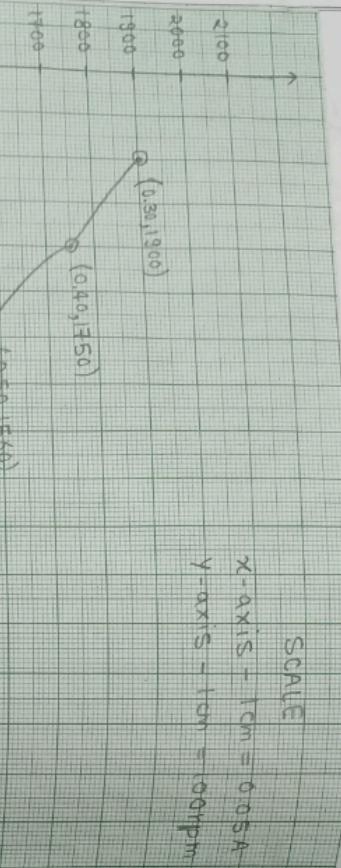
P = Total no. of poles

A = Total no. of parallel paths

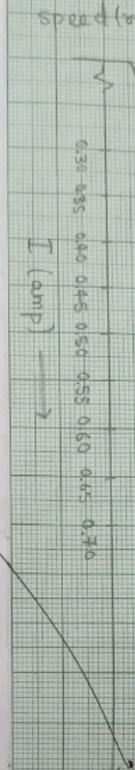
Substituting for E_b from eqⁿ ①, we get

$$\Phi N Z = V_t - I_a R_a$$

$$\Phi = \frac{V_t - I_a R_a}{N Z} \quad \text{--- (3)}$$



Speed v/s current curve



R_A is the resistance in armature circuit is made up of armature winding resistance & external resistance added in circuit (R_{ext}) is large as compared to R_g. I_AR_A will be approximately the voltage drop in the external resistance, where ($V - I_A R_A$) is voltage (V) across the armature terminal.

(a) So eqn ③ at constant flux becomes

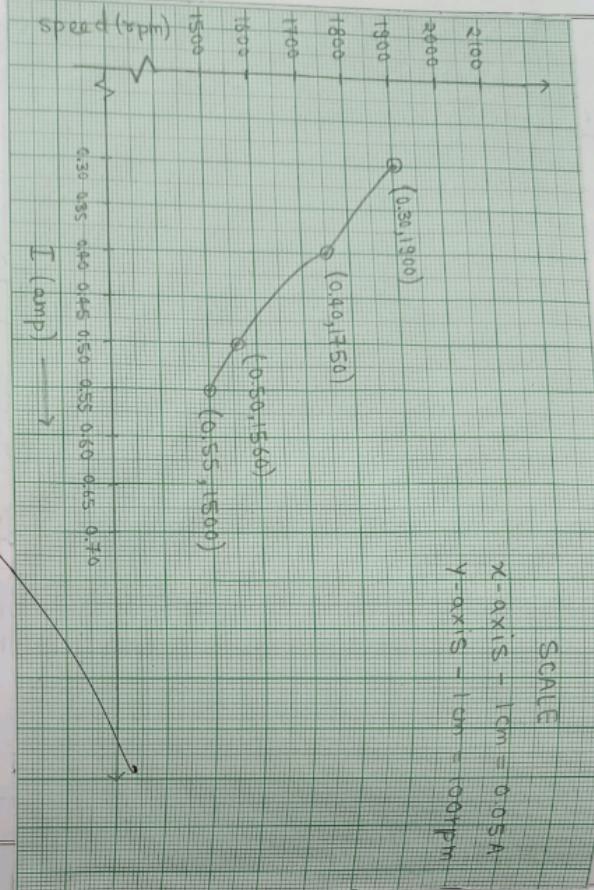
$$N \propto V \quad (4)$$

4th eqn gives method of speed control of D.C. shunt motor by armature resistance control. The speed decreases with decrease in voltage across armature which is obtained by varying the external resistance in series with armature.

(b) If voltage across armature terminal is constant

$$N \propto I \quad (5)$$

eqn 5 gives method of speed control of DC shunt motor by field resistance with decrease of flux and this is accomplished by increasing the resistance in field circuit.



Speed v/s current curve

(a) So eqn ③ at constant flux becomes

$$N \propto V - (4)$$

4th eqn gives method of speed control of D.C. shunt motor by armature resistance control. The speed decreases with decrease in voltage across armature which is obtained by varying the external resistance in series with armature.

(b) If voltage across armature terminal is constant

$$N \propto \frac{I}{\phi} \quad (5)$$

eqn 5 gives method of speed control of DC shunt motor by field resistance with decrease of flux and this is accomplished by increasing the resistance in field circuit.

Observation Table :-

I Constant

S.No.	Volts	N(rpm)
1	150	1050
2	160	1120
3	190	1260
4	220	1450

V Constant

S.No.	I (ampere)	N(rpm)
1	0.55	1500
2	0.50	1560
3	0.40	1750
4	0.30	1900

a) Supply is switched on with resistance in armature circuit kept at its maximum value and resistance in field circuit at its maximum field current is kept constant & speed of motor is measured corresponding to different values of external armature voltage by varying the external resistance in circuit from max to zero.

b) Voltage across armature is kept constant and speeds are measured corresponding to different values of field current by varying the resistance in field circuit from zero to a value which give a speed 20% higher than rated speed.

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Teacher's Signature

Experiment - 6

Aim : To perform load test on single phase transformer
 i) Draw curve Regulation vs output
 ii) Draw current efficiency vs output

Instruments Required :

S.No.	Name	Type	Range	Quantity
1.	Voltmeter	MT	(0-300) V	1
2.	Ammeter	MT	(0-15) A	1
3.	Wattmeter	Dynamometer	15A, 200V	1
4.	Lamp Load	Resistance	250V, 5KW	1

Theory :
 For transformer emf equation is

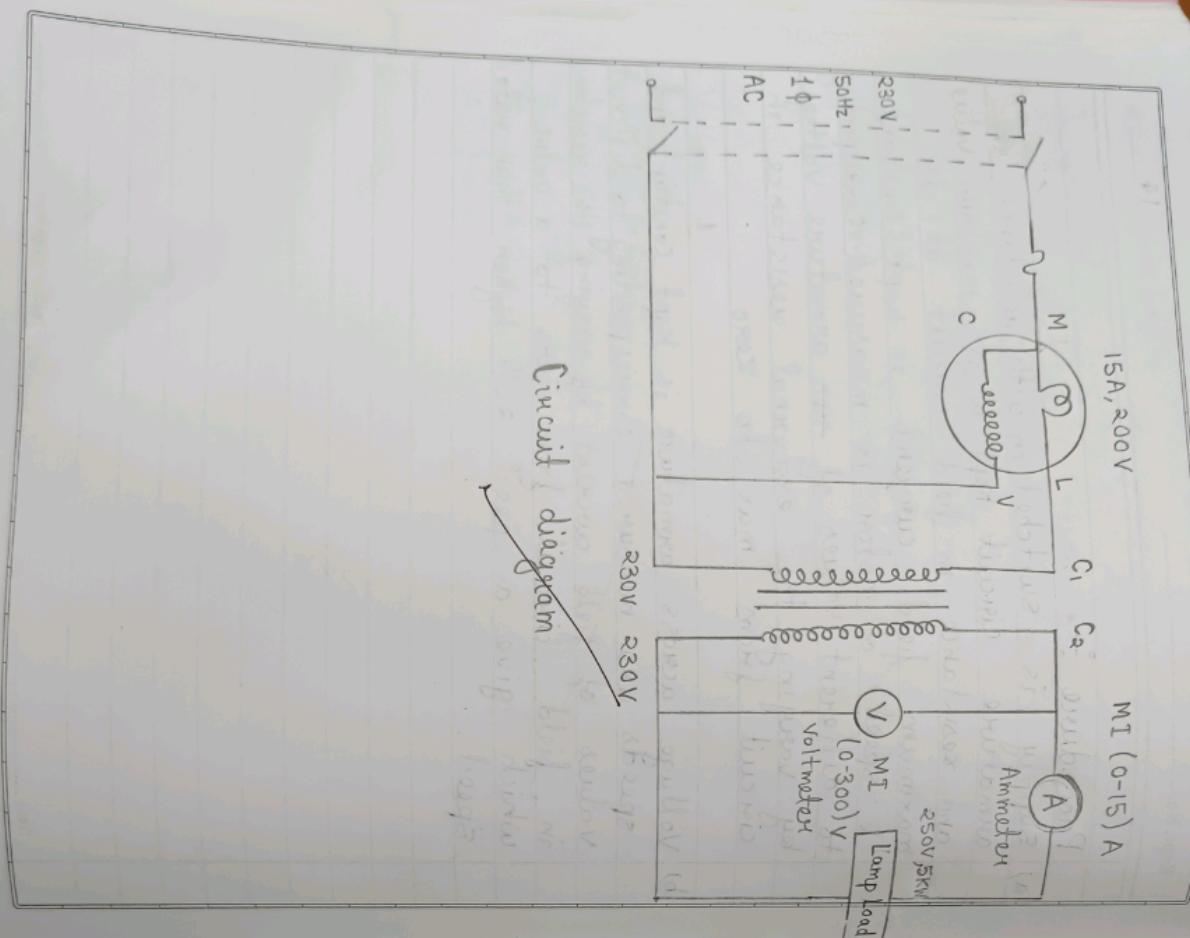
$$E = 444 \phi f T$$

Here, ϕ = useful flux in core
 f = frequency of supply

If T_1 & T_2 are no. of turns on primary and secondary winding respectively, then

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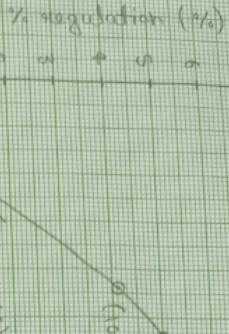
Teacher's Signature



$$\begin{aligned}x\text{-axis's - } & 2 \text{ mm} = 500 \text{ V} \\y\text{-axis's - load} & = 1\% \end{aligned}$$

$\frac{V_1}{V_2} = \frac{T_1}{T_2}$ is voltage ratio

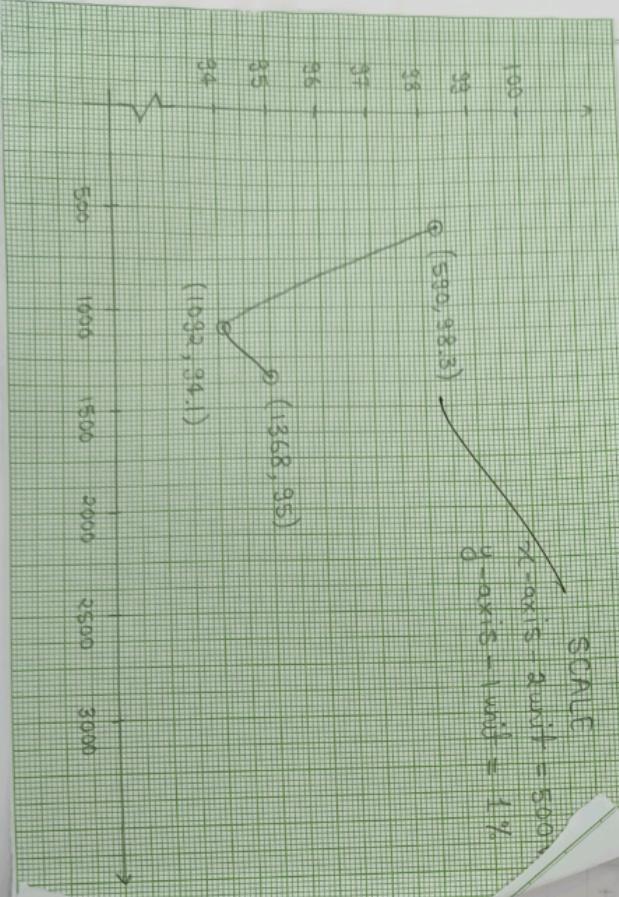
(1368, 5)
(1092, 4.16)



The regulation of transformer is change in Voltage from no load to full load but secondary side & it is compensated in terms of load resistance.

Procedure :-

1. Corrections are made for load test w.r.t circuit diagram.
2. Reading of instruments are taken by changing the load.
3. Connections are made for polarity test & reading of voltmeter are noted.
4. The connections are made for load test & the reading of instruments are taken by changing the load.



SCALE

x-axis's unit = 500

y-axis's - load = 1%

Observation Table :-

S.No.	Wattmeter Power input V	I	$P_{out} = VI$	% regulation	% efficiency
1	45	600	236	2.5	590 1.66 98.3 %
2	145	1160	230	4.75	1092 4.16 94.1 %
3	180	1440	228	6	1368 5.00 95 %

Calculations :-

$$\% \text{ Regulation} = \frac{V_{NL} - V_{FL}}{V_{NL}} \times 100$$

$$\% \text{ efficiency} = \frac{\text{output Power}}{\text{Input Power}} \times 100$$

$$\text{Mean \% regulation} = \frac{1.66 + 4.16 + 5}{3} = 3.6 \%$$

$$\text{Mean \% efficiency} = \frac{98.3 + 94.1 + 95}{3} = 95.8 \%$$

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Result :-

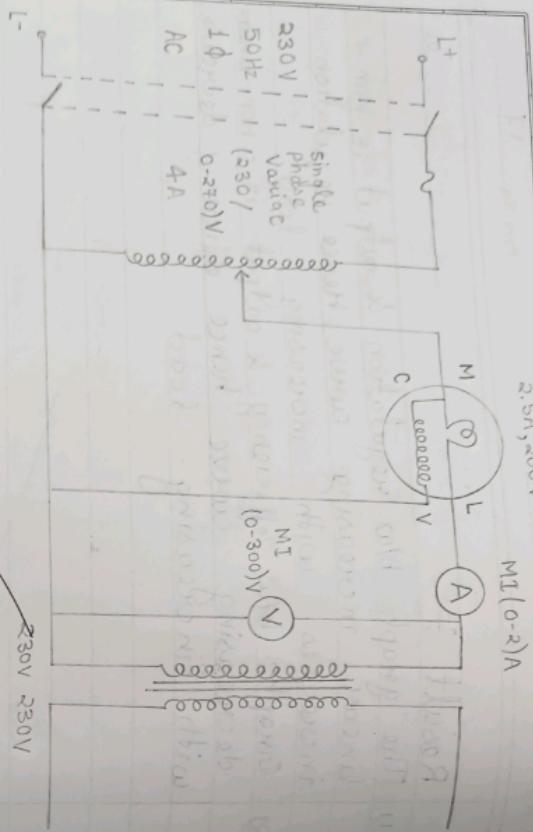
- 1) The graph shows regulation & output is non-linear increasing curve. Hence regulation increases with increasing load.
 2) Graph shows efficiency & output is a non-linear decreasing curve hence efficiency decreases with increasing load.

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Teacher's Signature

2.5A, 200V

M1(0-2)A



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Experiment - 7

Aim : To perform open circuit test on single phase transformer.

Instruments Required :

S.No	Name	Type	Range	Quantity
1	Variac	Single Phase	230/0-270; 4A	1
2	Wattmeter	-	2.5A/200V	1
3	Ammeter	M1	(0-2)A	1
4	Voltmeter	M1	(0-300)V	1

Theory :- It's one of winding of single phase transformer is kept open circuited, an AC supply is given to the other winding of the transformer. It takes small current called no-load current which is of 2-5% of full load current. The no load current has 2 components. The magnetising component producing flux in transition core and the working component to supply iron losses in the core. Small copper losses in the winding and this reduced current are negligible. Thus power input in this condition is equal to iron losses.

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Observation Table :-

V_o (Volts)	W_o (Watt)	Wattmeter reading (Watt) (amp)	I_o	$\cos \phi$	$\sin \phi$	I_w	I_m
230	3.7	29.6	1.1	0.117	0.993	0.128	0.1092

Calculation :-

$$\frac{V_o}{I_m} = \frac{230}{0.1092} = 2106.8 \text{ ohm}$$

$$R_o = \frac{V_o}{I_w} = \frac{230}{0.128} = 1806.2 \text{ ohm}$$

$$\cos \phi = \frac{W_o}{V_o I_o} = \frac{29.6}{230 \times 1.1} = 0.117$$

$$\sin \phi = \sqrt{1 - \cos^2 \phi} = \sqrt{1 - (0.117)^2} = 0.993$$

Procedure :- Connections are made for open circuit according to the diagram supply is switched on with variac on its min position. The voltage applied to the transformer is adjusted to its rated value. The reading of meters are recorded carefully and one set of reading corresponding to the rated value is sufficient to calculate complete result.

$$R_o = \frac{V_o}{I_w} = \frac{230}{0.128} = 1806.2 \text{ ohm}$$

Result :- No load equivalent parameters are -

$$X_o = \frac{V_o}{I_m} = \frac{230}{0.1092} = 2106.8 \text{ ohm}$$

and $R_o = 1806.2 \text{ ohm}$

Notes :- 1. The load current I_w is measured by ammeter and not by wattmeter.

2. The load current I_w is measured by ammeter and not by wattmeter.

taking place in it.

If W_o , V_o and I_o are the readings of wattmeter, Voltmeter and ammeter respectively during no load when connected as per diagram, the no load equivalent parameters are taken as

$$\cos \phi = \frac{W_o}{V_o I_o} \quad I_w = I_o \cos \phi \quad R_o = \frac{V_o}{I_w}$$

$$I_m = I_o \sin \phi$$

Procedure :- Connections are made for open circuit according to the diagram supply is switched on with variac on its min position. The voltage applied to the transformer is adjusted to its rated value. The reading of meters are recorded carefully and one set of reading corresponding to the rated value is sufficient to calculate complete result.

Result :- No load equivalent parameters are -

$$\cos \phi = 0.117, \sin \phi = 0.993$$

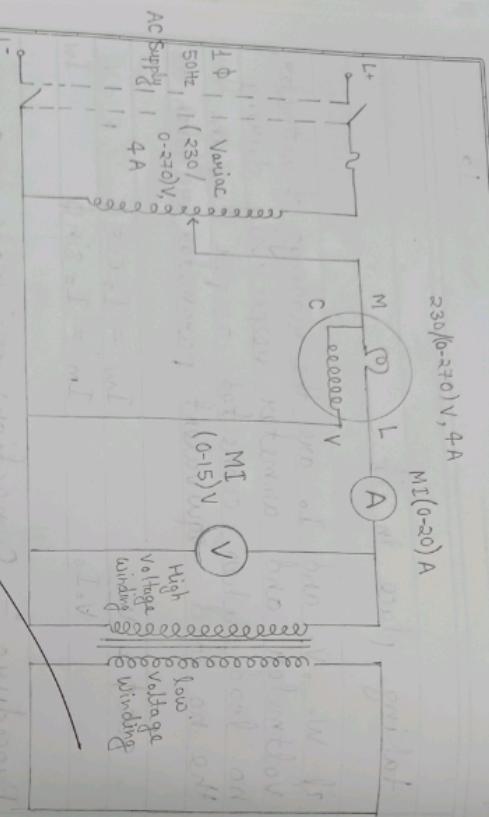
$$I_m = 1.092, I_w = 0.128$$

$$R_o = 1806.8 \Omega, X_o = 2106.8 \Omega$$

Experiment -8

Aim :- To perform short circuit test on 1- ϕ transformer.

Instruments Required :-



Ques. 1. What is short circuit test on transformer?

Ans. It is a test in which the secondary terminals of the transformer are short circuited and primary terminals are connected to an AC source.

Ques. 2. What is no load current of transformer?

Ans. It is the current flowing in primary when secondary terminals are short circuited.

Ques. 3. Define core loss of transformer.

Ans. It is the power consumed by the iron core due to hysteresis and eddy currents.

Ques. 4. Define leakage flux of transformer.

Ans. It is the flux which links only one part of the core.

Ques. 5. Define magnetizing current of transformer.

Ans. It is the current flowing in primary when secondary terminals are open circuited.

Ques. 6. Define no load loss of transformer.

Ans. It is the power consumed by the iron core due to hysteresis and eddy currents.

Ques. 7. Define no load voltage of transformer.

Ans. It is the voltage induced in the primary when secondary terminals are open circuited.

Ques. 8. Define short circuit voltage of transformer.

Ans. It is the voltage induced in the primary when secondary terminals are short circuited.

Ques. 9. Define short circuit ratio of transformer.

Ans. It is the ratio of no load voltage to short circuit voltage.

Ques. 10. Define efficiency of transformer.

Ans. It is the ratio of output power to input power.

Ques. 11. Define leakage reactance of transformer.

Ans. It is the reactance offered by the漏磁通 (leakage flux).

Ques. 12. Define magnetizing reactance of transformer.

Ans. It is the reactance offered by the main magnetic flux.

Ques. 13. Define no load current of transformer.

Ans. It is the current flowing in primary when secondary terminals are short circuited.

Ques. 14. Define magnetizing current of transformer.

Ans. It is the current flowing in primary when secondary terminals are open circuited.

Ques. 15. Define no load loss of transformer.

Ans. It is the power consumed by the iron core due to hysteresis and eddy currents.

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W_{sc} , I_{sc} and V_{sc} are reading of wattmeter, Ammeter and voltmeter respectively. The short circuit equivalent circuit parameters are calculated as follows:

$$Z_{sc} = \frac{V_{sc}}{I_{sc}}$$

$$R_{sc} = \frac{W_{sc}}{I_{sc}^2}$$

$$X_{sc} = \sqrt{Z_{sc}^2 - R_{sc}^2}$$

The regulation of transformer is the change in voltage at secondary terminal from no load to full load and is expressed as $\% \text{ regulation}$

$$\% \text{ Regulation} = [I_{sc} \cos \phi \pm I_{sc} \sin \phi] / V_{sc} \text{ where}$$

$$[I_{sc} \times R_{sc} \cos \phi \pm I_{sc} \times X_{sc} \sin \phi] \times 100 / V_{sc}$$

I_{sc} = load current
 V_{sc} = no load secondary voltage preferred to primary scale
 ϕ = power factor angle of load

Efficiency of transformer is defined as the ratio of output power to the input power

$$\text{Efficiency} = \frac{\text{Output Power}}{\text{Input Power} + \text{Iron loss} + \text{Cu loss}}$$

Observation Table :

I_{sc} (A)	V_{sc} (Volts)	I_{sc} (Secondary Current) amperes	W_{sc} (Watt)	Wattmeter Reading $W_{sc} \times M.F$
13	8	13	60	60

Calculations :

$$Z_{sc} = \frac{V_{sc}}{I_{sc}} = \frac{8}{13} = 0.615 \Omega$$

$$R_{sc} = \frac{W_{sc}}{I_{sc}^2} = \frac{60}{(13)^2} = 0.355 \Omega$$

$$X_{sc} = \sqrt{Z_{sc}^2 - R_{sc}^2} = \sqrt{(0.615)^2 - (0.355)^2}$$

~~$$= 0.502 \Omega$$~~

1. Connections are made for short-circuit test according to diagram.

2. It should be ensured that supply is switched on when the regulator is in its min position.
3. The voltage is adjusted so that the current flowing in short circuited winding is of rated value.

4. The reading of all the motors should be taken very carefully.

Results :

Value of $Z_{sc} = 0.615 \Omega$

Value of $R_{sc} = 0.355 \Omega$

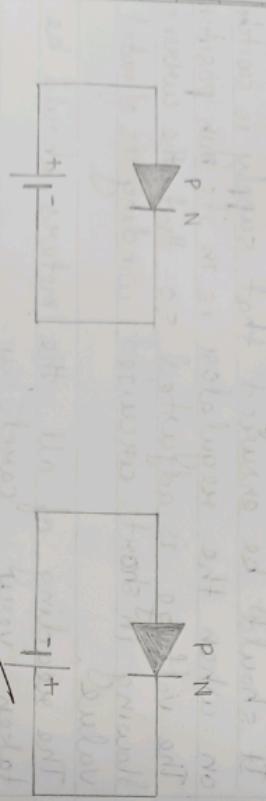
Value of $X_{sc} = 0.502 \Omega$

Experiment - 9

Conventional current direction in forward biasing



- (i) Circuit symbol of P-N Junction diode



(ii) Forward Biasing

(iii) Reverse Biasing

~~Diode~~

1. Theory :- Semiconductor diode - It is an electronic device which has conductivity intermediate b/w insulator and conductor

i) Intrinsic semiconductor (Pure)

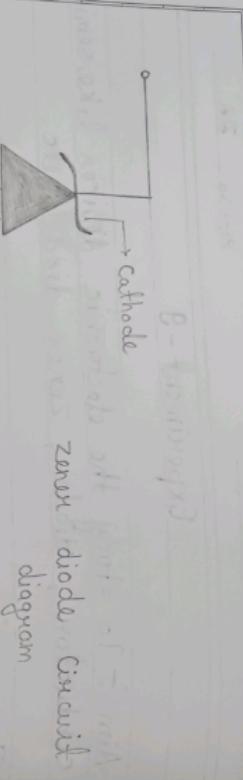
ii) Extrinsic semiconductor (impure/doped)

- Doping - Adding impurities to semiconductor At 0 Kelvin, a semiconductor behave as insulator

- P-Type semiconductor - When elements of group 13 is in periodic table doped with semiconductor Holes are the major charge carriers in P-Type

- N-Type semiconductor - Elements of group 14 are doped with group 15 elements like arsenic electrons are the majority charge carriers

- P-N junction diode - On joining P-Type & N-Type semiconductor we get P-N Junction Diode. These are 'non-ohmic' and have 'non linear characteristic'



Practical Application of Zener Diodes

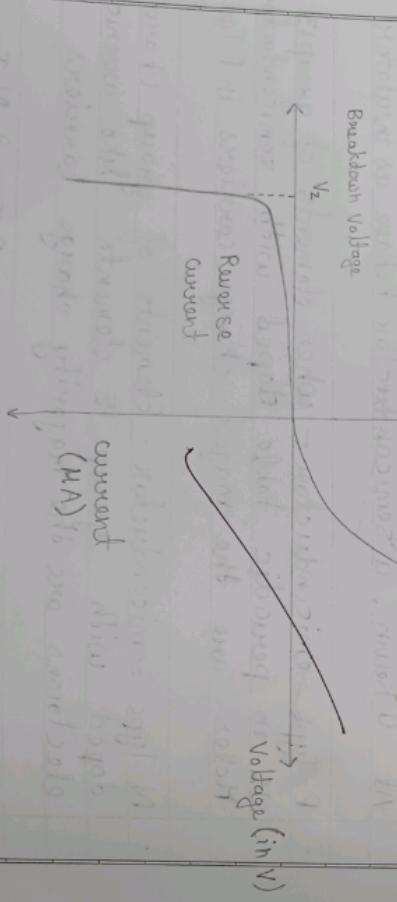
• Used in rectifiers \rightarrow To convert AC to DC
• In LCD
• In Laser
• In Solar cell

(iii) Zener Diode

• Zener Diode is a special type of diode which has been

Special Purpose Diode

Biassing - When a DC voltage is applied on a device it is said to be biassed.



i) Zener Diode - It is a special purpose diode which works in reverse biasing under breakdown region. In zener diode breakdown phenomenon is reversible and harmless. As reverse voltage is increased reverse current remains same up certain limit. The voltage at which reverse current suddenly increases is called zener breakdown voltage.

Characteristics of Zener Diode

• Zener diode is a special type of diode which has been used in rectifiers \rightarrow To convert AC to DC

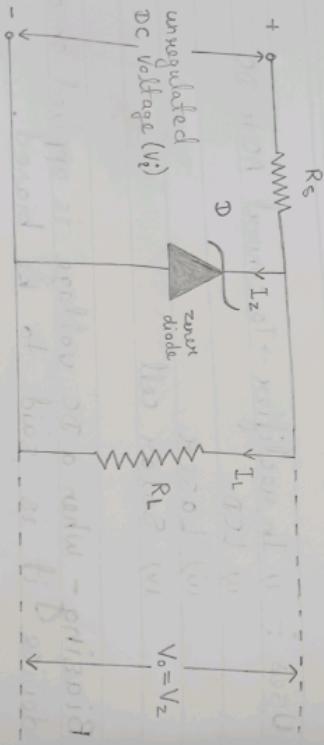
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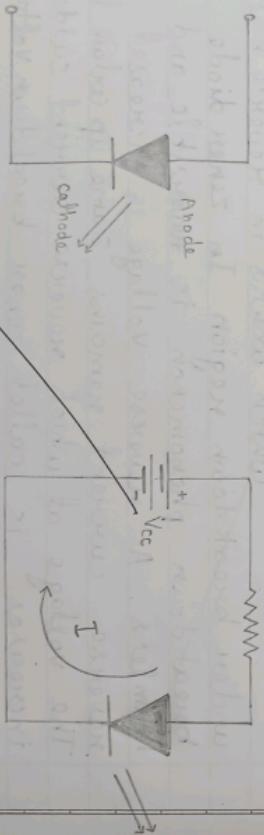
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$R_s \rightarrow$ current limiting resistor

Zener Diode as Voltage regulator



$R -$ current limiting

Circuit Diagram \rightarrow zener diode Resistor R

work of LED current limiting resistor

parallel with R \rightarrow Resistor

voltage regulator \rightarrow zener diode

constant voltage \rightarrow zener diode

Zener diode as Voltage regulator : A voltage regulator is a device used to produce constant voltage output even when either input voltage or load current varies. Zener diode act as voltage regulation, if can be used to provide constant voltage from source whose voltage may vary over a considerable range.

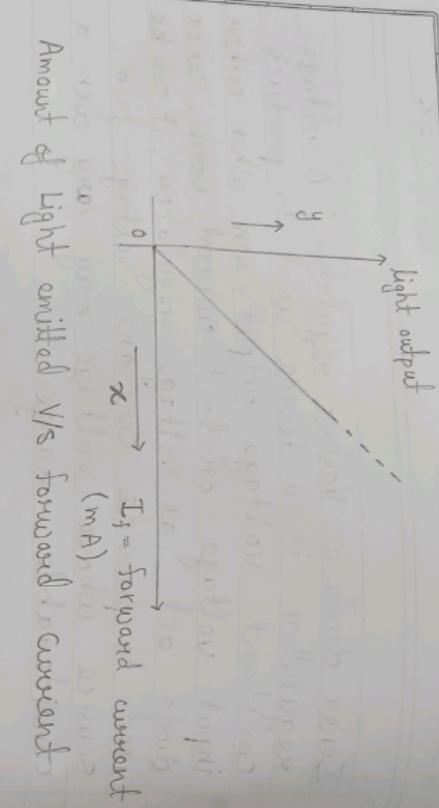
V_i is the regulated voltage source provided in input voltage. R_s - current limiting resistor across load resistor. Zener diode of zener voltage (V_z) is reverse connected across V_i . R_s across which constant output is desired is connected parallel with diode the series resistance R_s absorbed the output voltage fluctuating so as to maintain constant voltage across load. Zener diode has max current rating equal to I_z max.

R - current limiting
The zener diode current should not exceed the limit max current may go to zero.

LED (light emitting Diode) : It is the diode which gives light when it is forward biased.

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$I_f = \text{forward current}$

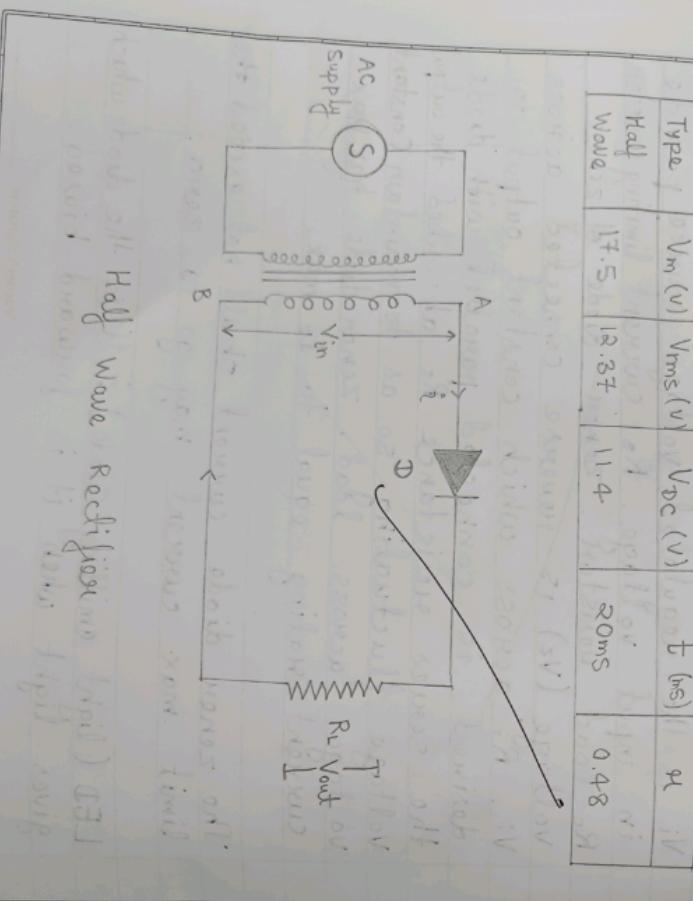
Principle : When P-N Junction diode is forward biased minority carriers flow in larger number when they combine with majority carriers producing light in visible or infrared region. The wavelength of light is given by $\lambda = \frac{hc}{E_g} = 1.24 \mu\text{m}$

This is called injection electroluminescence.

Rectifier : It is a device used to change AC to DC and it is a essential part of power supply current flows in one direction in a diode and thus property of diode is used in rectifier.

- Half-Wave Rectifier : Main power supply is applied at the primary coil of the step down transformer. All the positive half-cycle of the step down AC supply pass through the diode and all the negative half cycle get eliminated.

Peak value of the output is less than the peak value of the input voltage by 0.6V because of the voltage

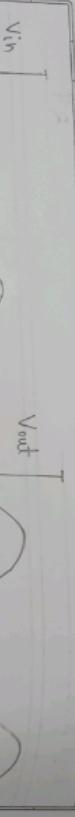


value both Half Wave Rectification (di) 33
doctor, breaking in India Isp

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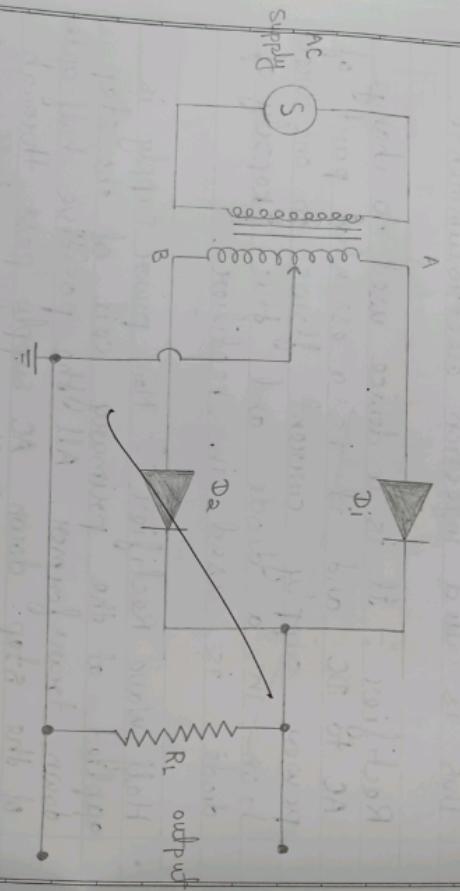


drop across the diode
for a half wave rectifier $V_{rms} = \frac{V_o}{\sqrt{2}}$

$$V_{dc} = V_{avg} = \frac{V_o}{\pi}$$

Operation of Half-Wave Rectifier

$$\text{Ripple factor } \kappa = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1}$$



Center tapped Full-Wave Rectifier
In this circuit, the AC source is connected to the center tap of the transformer. The two ends of the primary winding are connected to the AC source. The two ends of the secondary winding are connected to two diodes, D1 and D2, which are connected in opposite directions. The outputs of the diodes are connected to the load resistor RL.

Full-Wave Rectifier : During the positive half cycle of the transformer secondary voltage diode D1 is forward biased and D2 is reverse biased current flows through the D1 load resistance R & lower half of the transformer winding. So the current flows through the diode D1, load resistance & upper half of transformer winding. During the negative half cycle diode D2 becomes forward biased and D1 becomes reverse biased. The current flows through the diode D2, load resi stance RL & lower half of the transformer winding.

Current flows through the resistor in the same direction during both the half cycles. Peak value of the output voltage is less than the peak value of the input voltage by 0.6 V because drop of voltage across the diode.

$$\text{For full-wave rectifier } V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$$

$$\text{Ripple factor, } \mu = \sqrt{\left(\frac{V_{\text{rms}}}{V_{\text{DC}}}\right)^2 - 1}$$

~~operation of full-Wave rectifier~~

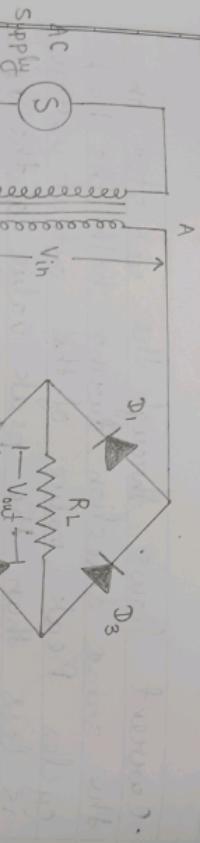
i) centre tap
ii) Bridge

Full-Wave rectifier have two types :-

Type	V_m (v)	V_{rms} (v)	V_{dc} (v)	t (ms)	μ
full Wave	20 v	14.14	12.37	20 ms	0.48

- i) Bridge Rectifier :- During the positive half cycle of the secondary voltage diodes D_1 & D_2 are forward biased & D_3 & D_4 are reverse biased.

In positive half cycle current flows through secondary winding, diode D_1 forward biased & D_2 reverse biased.



Full-Wave Bridge Rectifier

During both the half cycle the current flows through the load resistance in the same direction, peak value of the output voltage is less than the peak value of input voltage by 1.2V due to the voltage drop across 2 diodes. The ripple factor of the bridge rectifier is same as that of full wave rectifier.

Output and reading now
No. of cycles observed = 100
Average ampere = 4.00

Structure

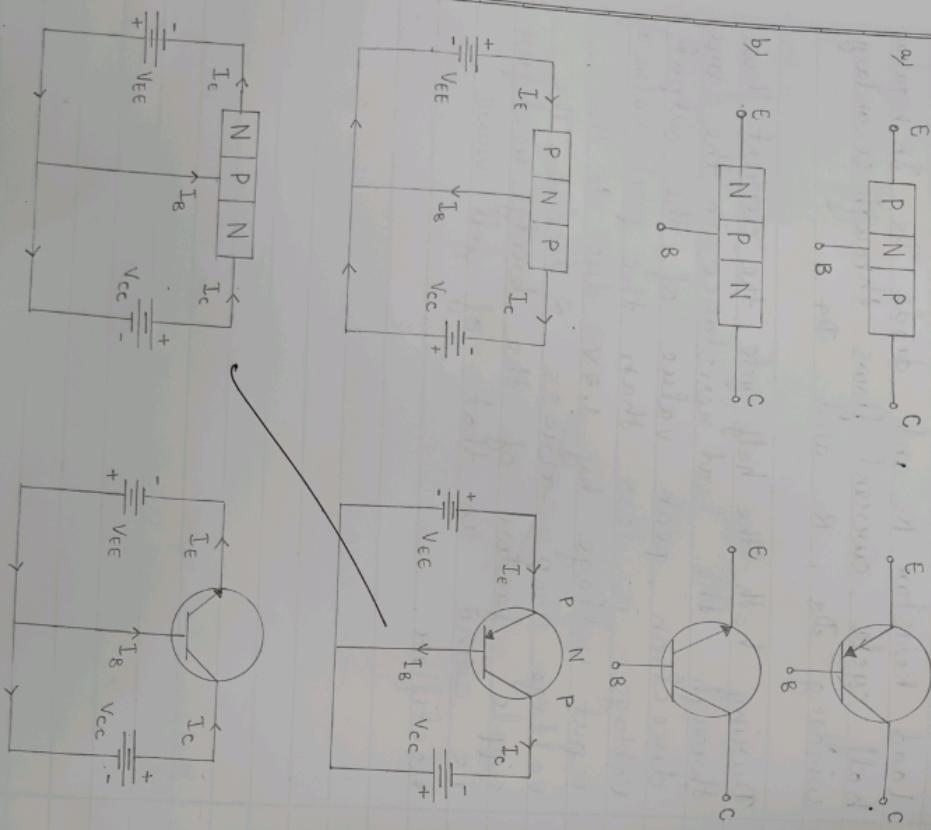
Symbol

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Experiment - 10

Aim : Study of the electric components like transistor and their various configuration (common Base, Common Emitter, Common Collector)



- **Transistor :** Transistor is a type of semiconductor device that can be used to both conduct and insulate electric current or voltage. It basically acts as a switch and an amplifier. Therefore a transistor is a miniature device used to control or regulate the flow of electronic signals. The word trans means resistance property offered to the functions. The transistors consist two P-N Junction diodes connected back to back. It has three terminals namely emitter, base, and collector. The base is middle section which is made up of thin layer. The right part of the diode is called emitter diode and the left part is called collector diode.
- **Emitter :** It is the rightmost part of the transistor. It is heavily doped for load of the transistor. It supplies a large number of majority charge carriers.

Biasing in PNP and NPN Transistors

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carriers to the base. It is connected to base in forward bias. It is moderate in size. Base \therefore It is the middle part of transistor used to activate the transistor. It is central segment and lightly doped and very thin due to which it offers the majority charge carriers to the base.

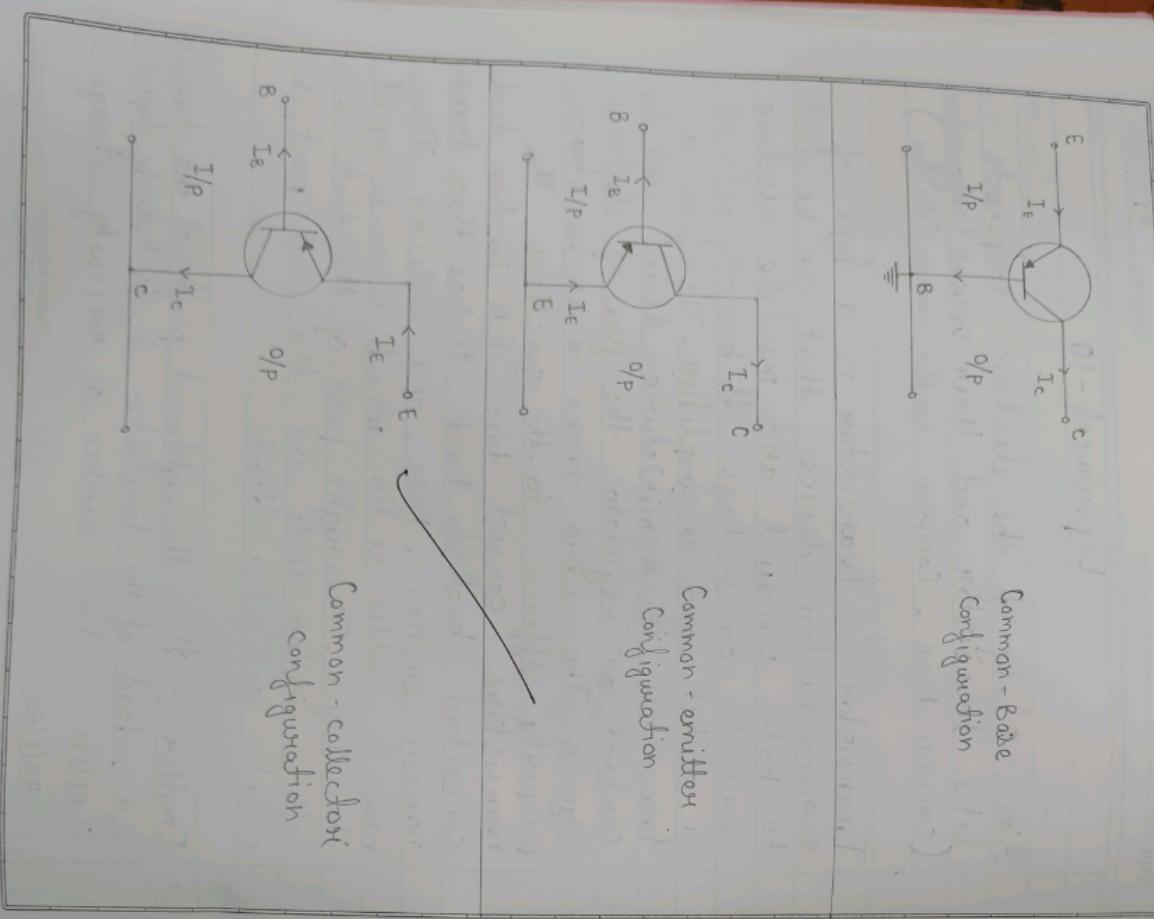
- Collector \therefore It is the left most part of the transistor. Positive load of transistor. It is longest in size and moderately doped. It collects a majority change carriers. It is connected to base in reverse biased.

- PNP - Transistor \therefore Types of BJT where one n-type material is introduced or placed between 2 p-type material control flow of current. The right side & left side of diode are known as collector base diode & emitter base diode. Holes are the majority charge carriers while electrons are minority.

- NPN - Transistor \therefore Type consist of n-type semi-conductor that sandwiched with p-type.

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Here electrons are the majority charge carriers while Holes are minority charge carriers made up of material like silicon or Germanium

Transistor Biasing : For proper working of transistor

- i) Emitter : Base Junction should be forward biased.
- ii) Collector : Base Junction should be reverse biased

~~if emitter - Base Junction is not forward biased, transistor will never conduct any current.~~

Transistor Current

I_E - emitter current I_B - Base current

I_C - collector current

Only a small part of emitter current goes to base current and most part is in form of collector current

$$I_E = I_B + I_C$$

* Transistor Circuit Configuration

1. Common Base (CB) : In the CB configuration Base terminal taken as common for both Input and

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output. Input is applied b/w emitter and Base terminal and output is taken b/w base and collector.

$$\alpha = \frac{\Delta I_c}{\Delta I_E}$$

$$\alpha = - \frac{I_c}{I_E}$$

-ve sign shows the direction of current flow
 +ve → input current
 -ve → output current

- a. Common emitter (CE) : In common emitter configuration emitter terminal is taken as common for both input and output. So input is given between Base and emitter terminal and output is taken between emitter and collector terminal. This is most commonly used configuration.

$$\beta = \frac{I_c}{I_B}$$

• Relation Between α & β

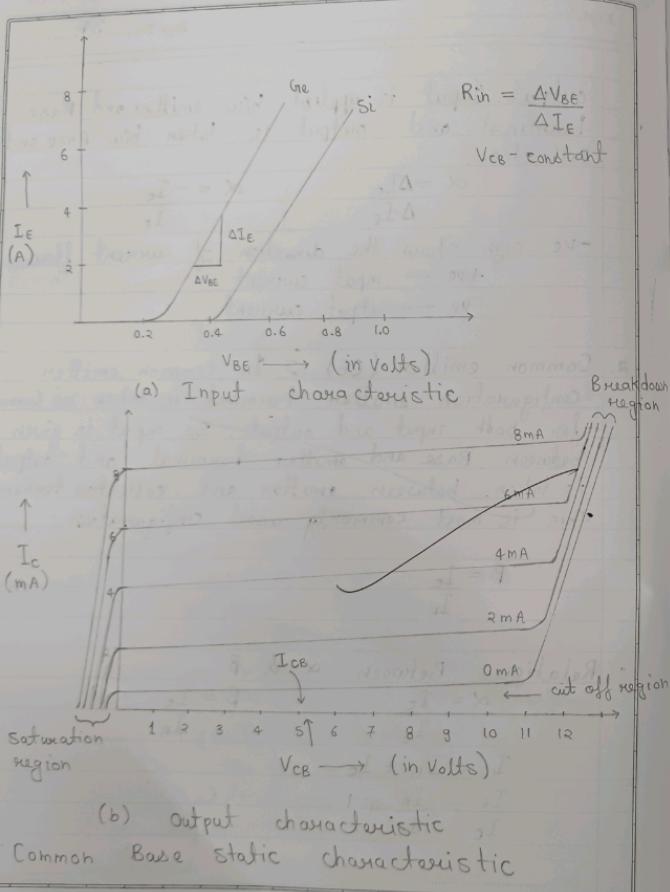
$$\alpha = \frac{I_c}{I_E} \quad \beta = \frac{I_c}{I_B}$$

$$I_E = I_B + I_c$$

$$\frac{I_E}{I_c} = \frac{I_B}{I_c} + 1$$

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$$\frac{1}{\alpha} = \frac{1}{B} + 1$$

$$\alpha = \frac{B}{1+B}$$

$$1-\alpha = \frac{1}{1+B}$$

3. Common Collector (CC) : In CC configuration collector terminal is taken common. So input is supplied to Base-collector and output is taken between collector and emitter terminal.

* Transistor static characteristic :

→ Common Base static characteristic

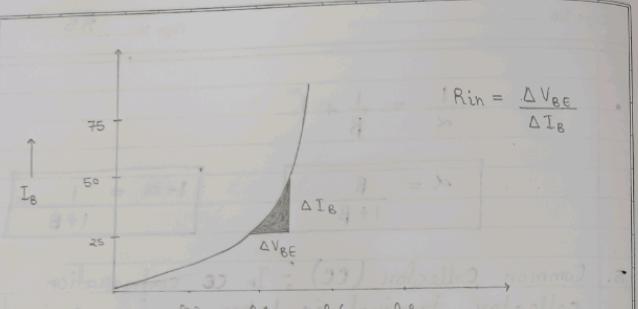
a) Input characteristic

It shows low I_E . Varies with V_{BE} . When voltage V_{CB} is held constant. The method of characteristic is as follows - Both curves are exactly similar to forward characteristics of P-N diode which is in essence is what emitter-base junction is.

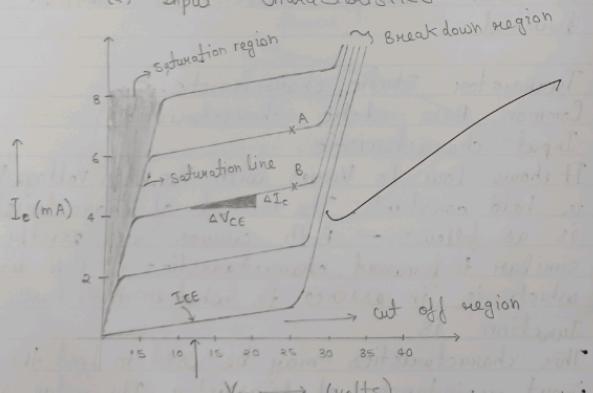
This characteristic may be used to find the input resistance of transistor. Its value is given by reciprocal of its slope.

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(a) Input characteristics



(b) Output characteristics

Common-Emitter static characteristics

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$$R_{in} = \frac{\Delta V_{BE}}{\Delta I_B} \rightarrow V_{CB} \text{ constant}$$

This characteristic is hardly affected by change in either V_{CB} or temperature.

Output characteristics : It shows I_C varies with I_E when V_{CE} is held constant.

It may be seen that I_C flows even when $V_{CE}=0$ for example due to fact e⁻ are being injected to the base under the action of forward biased E/B Junction and are being collected by the collector due to the action of internal Junction voltage at C/B Junction for reducing I_C to zero. its essential to neutralise its potential barrier by applying small forward bias across C/B junction.

* Common emitter static characteristic

a) Input characteristic : I_B varies with change in V_{BE} when V_{CE} is held constant at particular value. Reciprocal of slope gives the input resistance R_{in} of transistor

$$R_{in} = \frac{1}{I_B / \Delta V_{BE}} = \frac{\Delta V_{BE}}{I_B}$$

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b) Output characteristic : It shows the variation of I_c with change in V_{ce} when I_b is constant. It can be seen that V_{ce} increases from 0, I_c rapidly increases to a new saturation level for a fixed value of I_b . As shown, a small amount of collector current flows when $I_b=0$. It is called I_{ceo} since main collector current is 0. Transistor is said to be cut off.

08/02/23