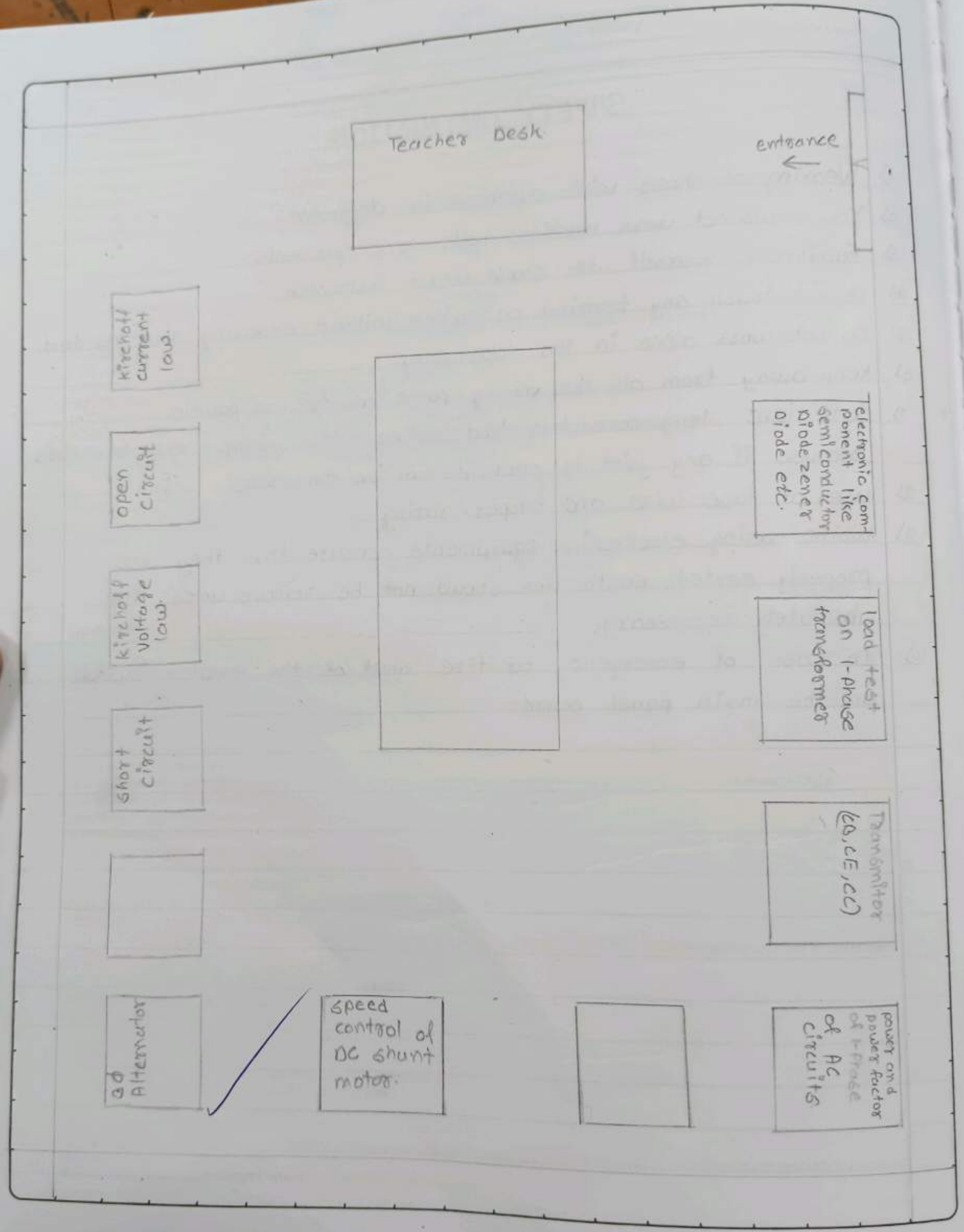
Camlin Page No. 1
Date / /

Experiment Name / No.:

SAFETY INSTRUCTION.

1) Wearing of shoes with rubber is desirable.
2) You should not work machines with loose garments.
3) Familarise yourself with shock chorst instruction
4) Do not touch any terminal on switch without ensoring 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 electronin equipments, ensure that they are properly earted, earth link should not be remove unless its absolutely neccessary.
10) In case of emergency or fire, shut of the master switch on the main panel board.

Teacher's Signature:



Teacher Desk
entrance
Kirchoff current low.
open circuit
Kirchoff voltage low.
short circuit
3Φ Alternator
speed control of DC shunt motor.
electronic component like semiconductor Diode zener Diode etc.
load test on 1-Phase transformer
Transmitter (CB, CE, CC)
power and power factor of 1-Phase of AC circuits

Experiment Name / No.:

Camlin Page No. 2
Date / /

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.

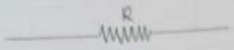
8) To perform short circuit test on single phase transformer.

9) Study of electronic component like semiconductor, diode, zener diode etc.

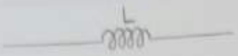
10) Demonstration of Half wave and full wave rectifire.

11) To study the transistor and their varius configurations. (common base, common emmiter, common collecter).

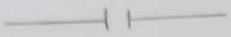
Teacher's Signature:

1. 

Resistance.

2. 

inductor.

3. 
capacitor.

4. 

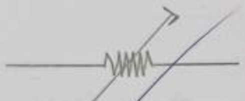
AC source.

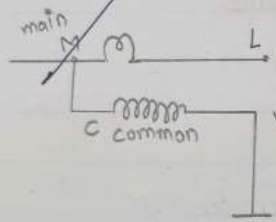
5. 

DC voltmeter.

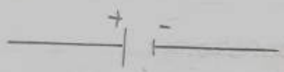
6. 

DC Ammeter.

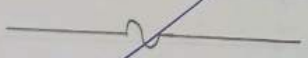
7. 
variable resistance

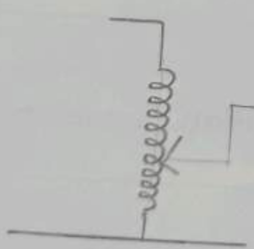
8. 

Load.
Voltage across.

9. 

DC Source.

10. 
Fuse

11. 
Single phase varie.
(variable transformer).

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	82	75	155	3.12

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

$$= 1.96\ \%$$

Experiment - 1

Aim :- To verify Kirchoff's voltage law

Apparatus Required :-

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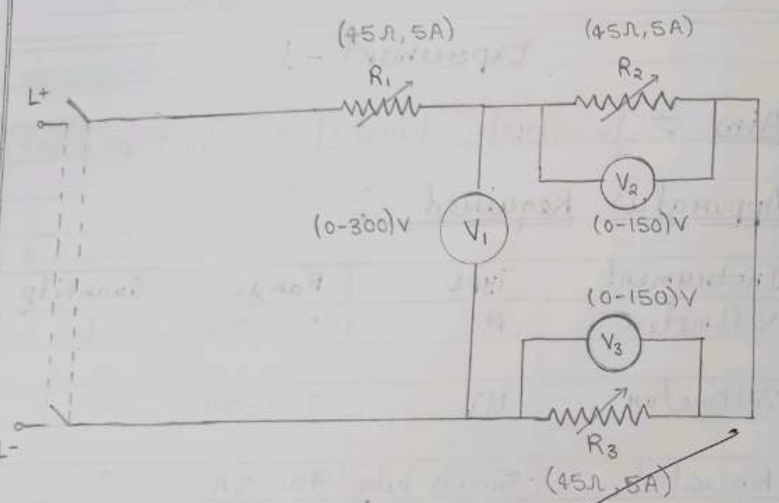
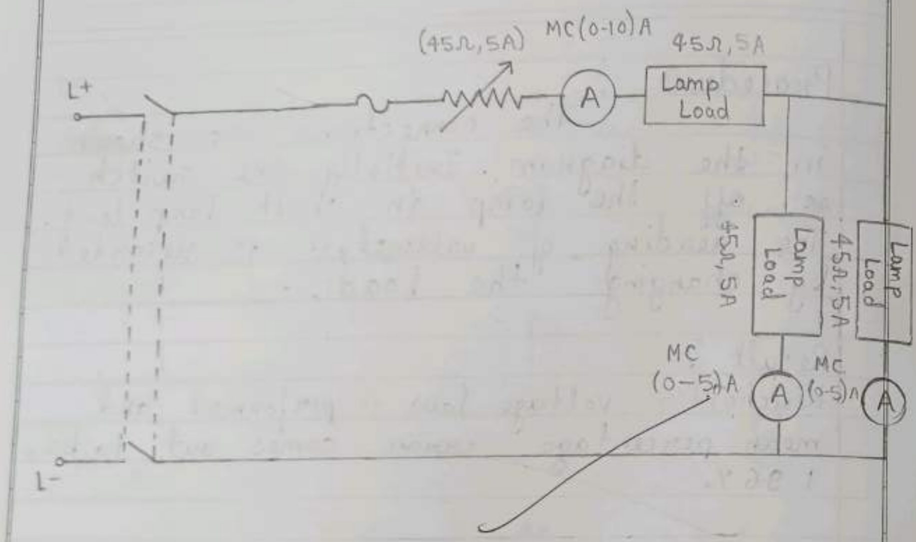


Circuit Diagram

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

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



Experiment -2

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 connected. The reading of

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observation Table :-

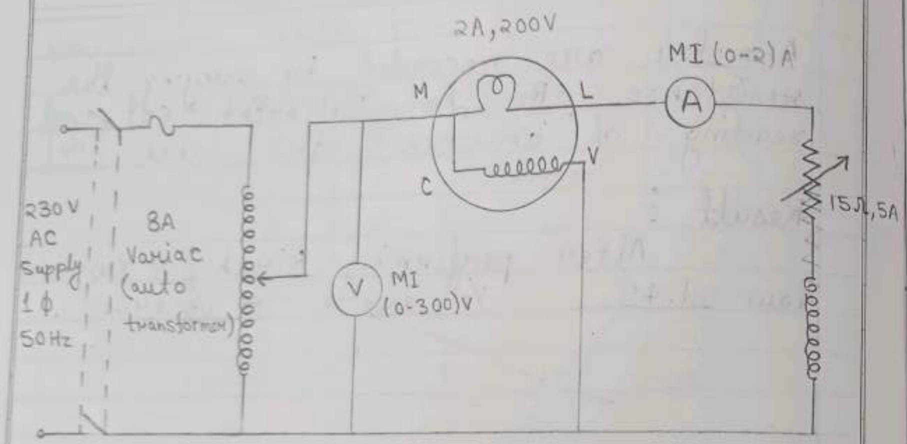
S. No.	I_1 (A)	I_2 (A)	I_3 (A)	$I_2 + I_3$ (A)	Error
1.	1.8	0.6	1.2	1.8	0.0
2	1.4	0.7	0.7	1.4	0.0
3	2.2	1	1.2	2.2	0.0
4	3.4	1.2	2.0	3.2	5.8

$$\text{mean \% error} = \frac{0+0+0+5.8}{4}$$
$$= 1.45\%$$

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

Result :-

After performing Kirchoff's current law 1.45 % error is observed.



Circuit diagram to measure Power and power factor of AC circuit.

Experiment 3

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

Apparatus Required :-

S.No.	Name	Type	Range	Quantity
1.	Voltmeter	MI	(0-300) V	1
2.	Wattmeter		2A, 200 V	1
3.	Ammeter	MI	(0-2) A	1
4.	Variac		230V; (0-270) 8A	
5.	Rheostat		15Ω, 5A	1

Theory :-

In AC circuit, both voltage and current vary sinosoidaly 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 $P = VI\cos\phi$ when 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.

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 autotransformer preferably around 150 V.

S. No.	Voltmeter (V)	Ammeter (A)	Power Wattmeter (W) x (mF)	(VI)	Power factor
1	220	0.9	4.1x8 = 32.8	198	0.165
2	230	1.0	4.6x8 = 36.8	230	0.160
3	240	1.2	5.2x8 = 41.6	288	0.144
4	250	1.4	5.7x8 = 45.6	350	0.130

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

$$= 0.149$$

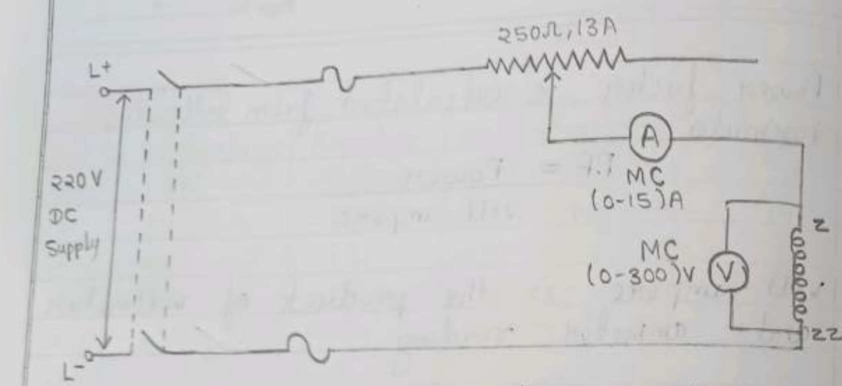
2. Power factor is calculated from following formula —

$$PF = \frac{\text{Power}}{\text{Volt-ampere}}$$

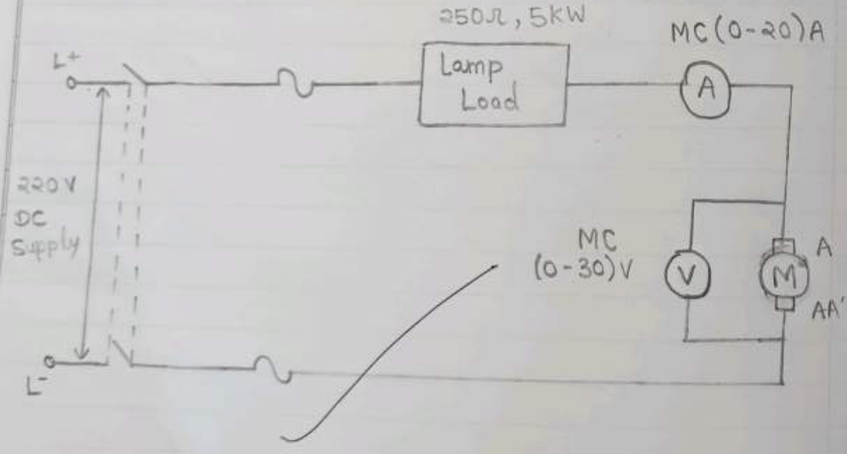
Volt - ampere is the product of voltmeter and ammeter reading.

Result :-

The power factor for 1-ϕ AC circuit is 0.149.



Measurement of shunt field winding resistance



Measurement of armature resistance

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Experiment-4

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

Name plate specification of machine

BHP/KW : 7.5HP
Voltage : 250V
Amperes : 15A
RPM : 1500 rpm

Instruments required

S.No	Instrument	Type	Range
1	Ammeter	MC	0-20 A
2	Ammeter	MC	0-15 A
3	Voltmeter	MC	0-30V
4	Voltmeter	MC	0-300V
5	Rheostat	Single tube	250Ω, 13A
6	Lamp load	resistance	250Ω, 5kW

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

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

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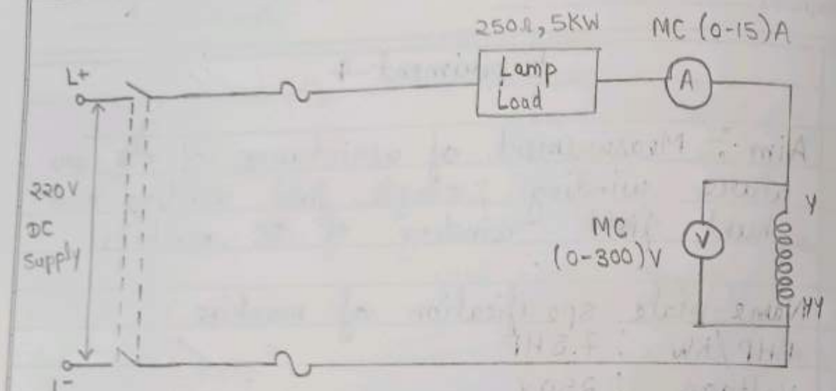

Series field winding Resistance

<u>Observation table</u>

1. Armature resistance

S.No.	I (amp)	V (volt)	R (ohm)
1.	2.8	2.4	0.85
2.	3.6	2.5	0.69
3.	6.6	5.0	0.75
4.	9.0	7.0	0.77

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

Procedure :-

1. Measurement of armature resistance, series field resistance. Connection are made as shown in figure, the reading of values of ~~two~~ 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.

2. Measurement of shunt field resistance. Connections are made as shown in figure. The reading of various meters are noted down for various values of shunt field currents. The shunt field current is carried by a rheostat used as a variable resistance.

Calculations :-

According to ohm's law $V = IR$

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

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:-

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

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

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

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

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 28.90Ω

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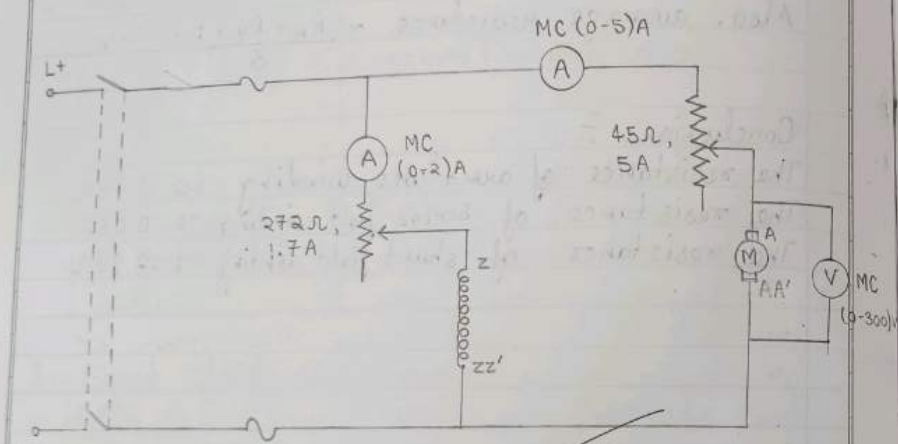

Circuit Diagram

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	Techometer	–	0-2000 rpm
2	Rheostat	Single tube	272Ω, 1.7 A
3	Rheostat	Single tube	45 Ω, 5A
4	Voltmeter	MC	0-300 V
5	Ammeter	MC	0-2A, 0-5A

Name plate specification of Machine

DC Component . machine
BHp / KW . 5Hp
Voltage : 220 V
Ampere : 18A
RPM : 1500 rpm

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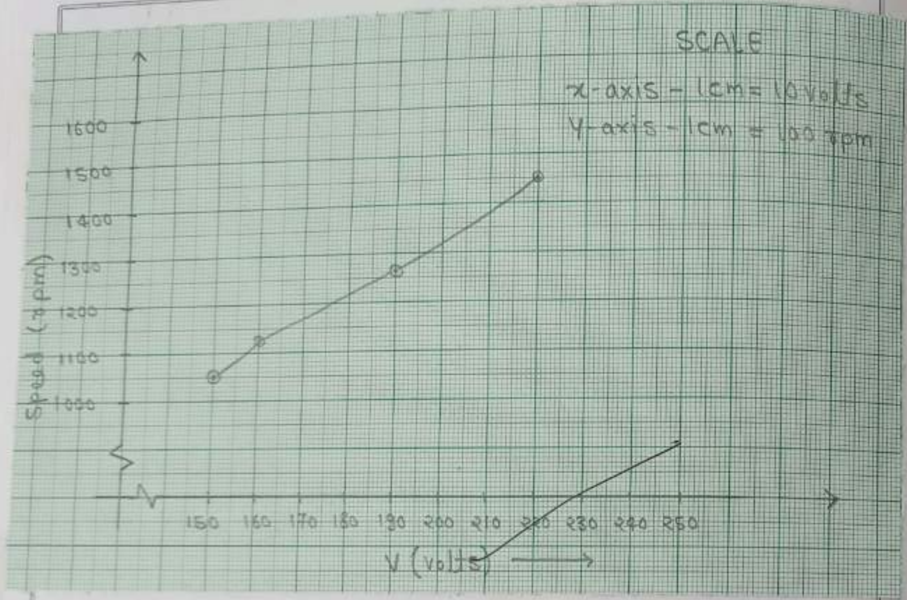


Speed v/s Voltage Curve

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, Ampere
R_A = Resistance, ohms

Back emf is given by

$$E_b = P\phi NZ/60A \quad \text{—— (2)}$$

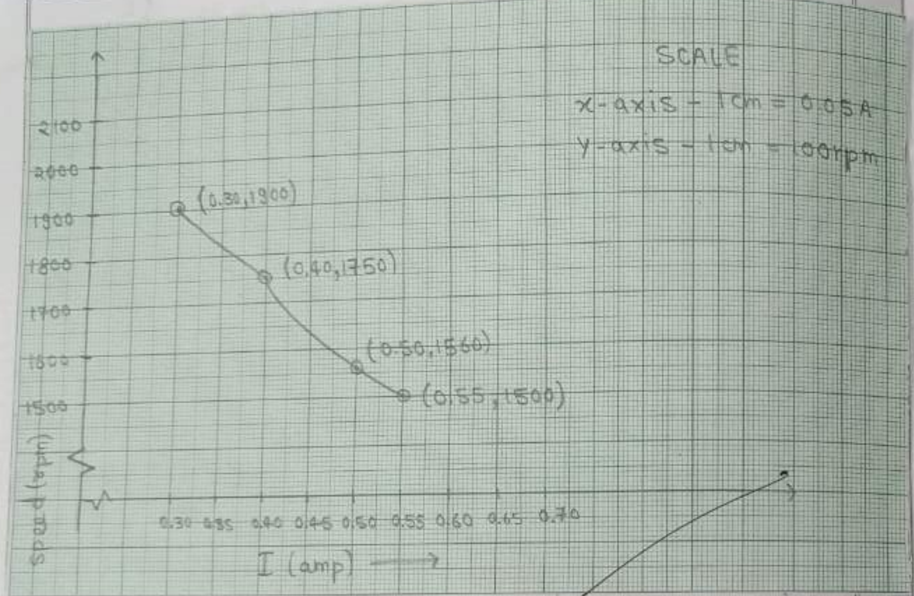
where,

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 eq^n ①, we get

$$P\phi NZ = V_t - I_A R_A$$

$$N = \frac{K(V_t - I_A R_A)}{\phi} \quad \text{—— (3)}$$



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_f. $I_A R_A$ will be approximately the voltage drop in the external resistance, there $(V_t - I_A R_A)$ is voltage (V) across the armature terminal.

(a) So eqⁿ ③ at constant flux becomes

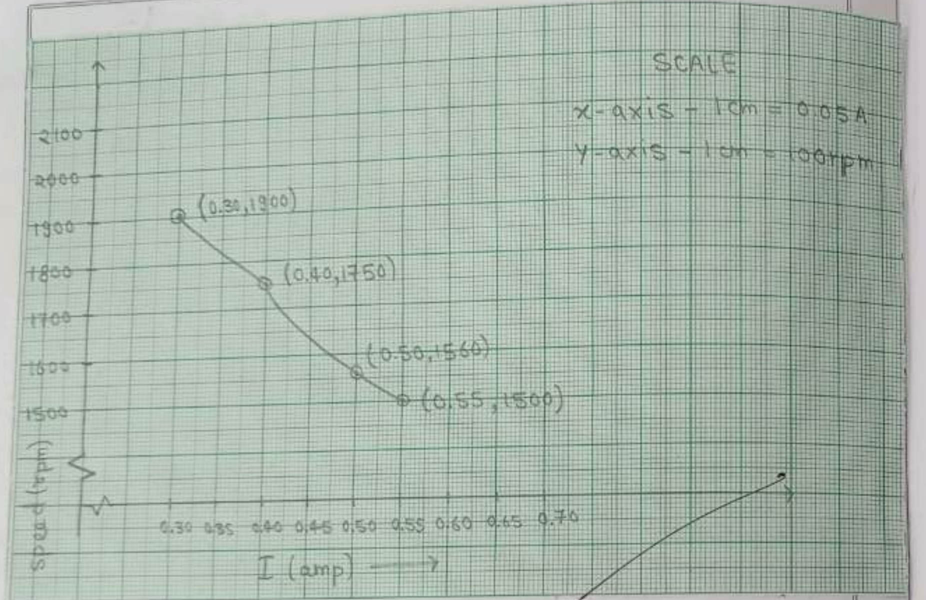
$$N \propto V \quad \text{———} \quad (4)$$

~~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

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

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



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. $I_A R_A$ will be approximately the voltage drop in the external resistance, there $(V_t - I_A R_A)$ is voltage (V) across the armature terminal.

(a) So eq^n ③ at constant flux becomes

$$N \propto V \quad \text{——} \quad (4)$$

4^{th} eq^n 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

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

eq^n 5 gives method of speed control of DC shunt motor by field resistance with decrease of flux and this is a 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

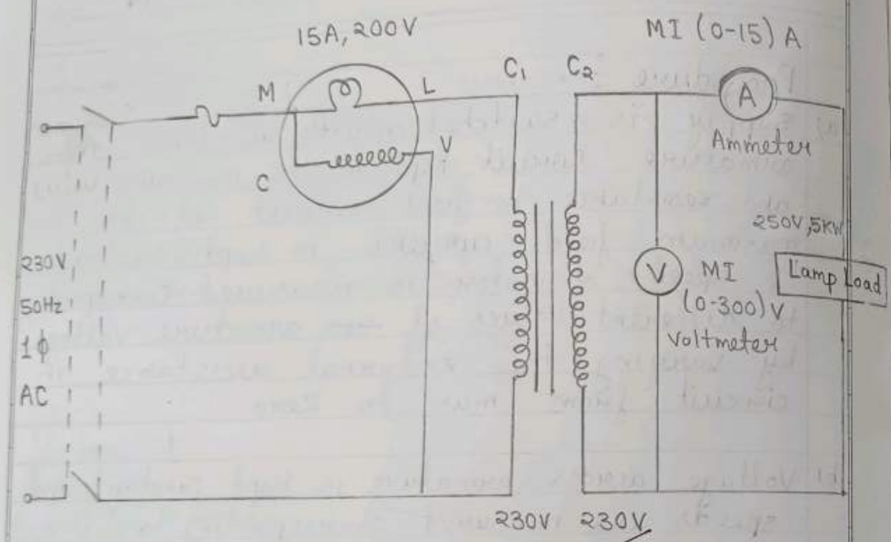
V Constant

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

Procedure :-

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 ~~res~~ 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.



Circuit diagram

Experiment - 6

Aim :- To perform load test on single phase transformer

i) Draw curve Regulation V/S output
ii) Draw curve efficiency V/S output

Instruments Required :-

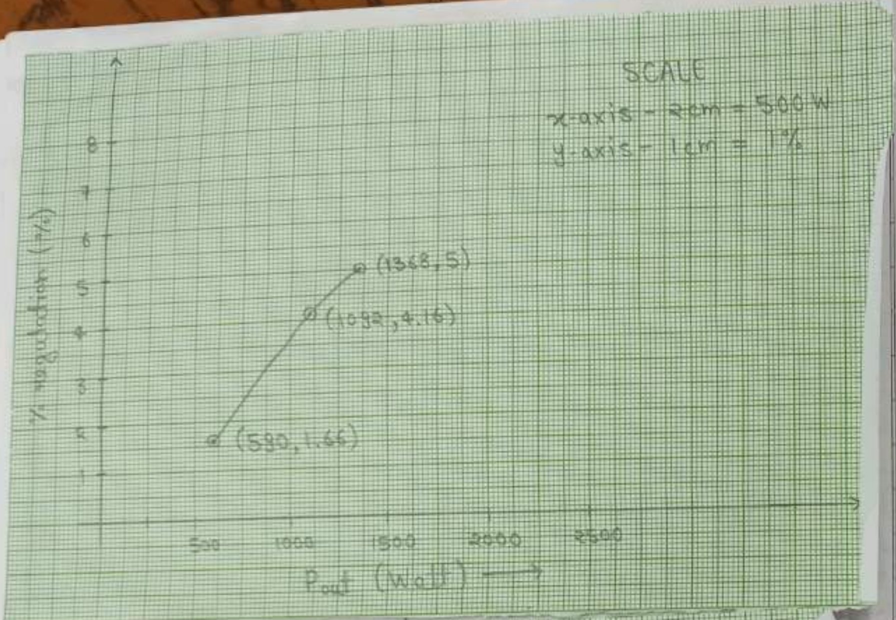
S.No	Name	Type	Range	Quantity
1.	Voltmeter	MI	(0-300) V	1
2.	Ammeter	MI	(0-15) A	1
3.	Wattmeter	Dynamometer	15A, 200V	1
4.	Lamp load	Resistance	250V, 5KW	1

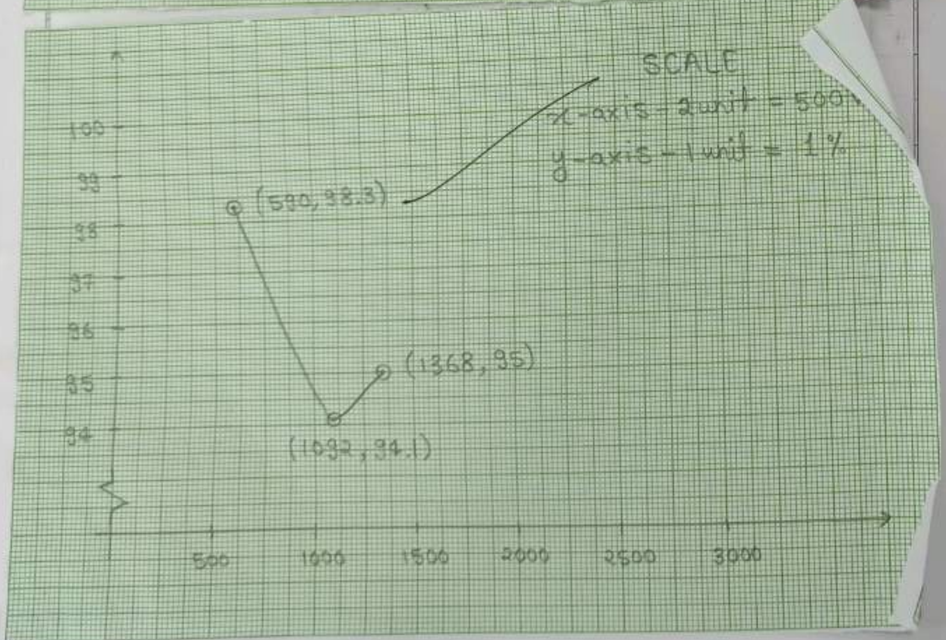
Theory :-
For transformer emf equation is

$$E = 4.44\ \phi f T$$

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

if $V_2 > V_1$ the emf in winding have an additive property. But subtract if $V_2 < V_1$. In standard substractive polarity is considered because it reduces voltage stress b/w adjacent load.

The regulation of transformer is change in voltage from no load to full load but secondary side & it is empressed in trans of load resistance.

Procedure :-

1. Connections 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.

Date .... Teacher's Signature. ....

Observation Table :-

S.No.	Wattmeter	Power input	V	I	$P_{out} = VI$	% regulation	% efficiency
1	75	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 :-

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

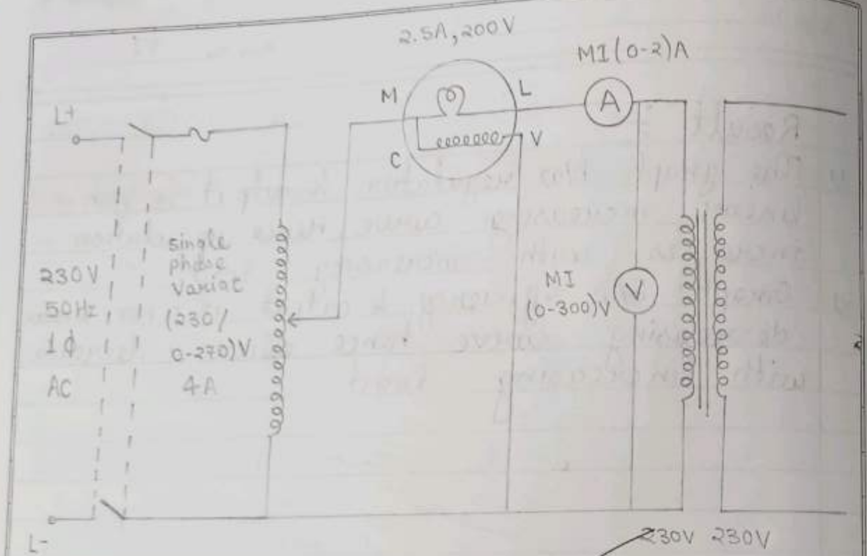
$$\% \text{ efficiency} = \frac{\text{output Power}}{\text{Input Power}} \times 100$$

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

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

Result :-

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



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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	MI	(0-2)A	1
4	Voltmeter	MI	(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 Iw 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

Date 11/1/23 Teacher's Signature ____

Observation Table :-

V_o (Volts)	W_o (Watt)	Wattmeter reading ($W_o \times MF$)	I_o (amp)	$\cos\phi$	$\sin\phi$	I_W	I_M
230	3.7	29.6	1.1	0.117	0.993	0.128	1.092

Calculations :-

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

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

$$I_M = I_o \sin\phi = 1.092$$

$$I_W = I_o \cos\phi = 0.128$$

$$R_o = \frac{V_o}{I_W} = \frac{230}{0.128} = 1796.8\,\Omega$$

$$X_o = \frac{V_o}{I_M} = \frac{230}{1.092} = 210.6\,\Omega$$

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 parameter are taken as-

$$\cos\phi = \frac{W_o}{V_o I_o} \qquad I_W = I_o \cos\phi \qquad R_o = \frac{V_o}{I_W}$$
$$I_m = I_o \sin\phi$$

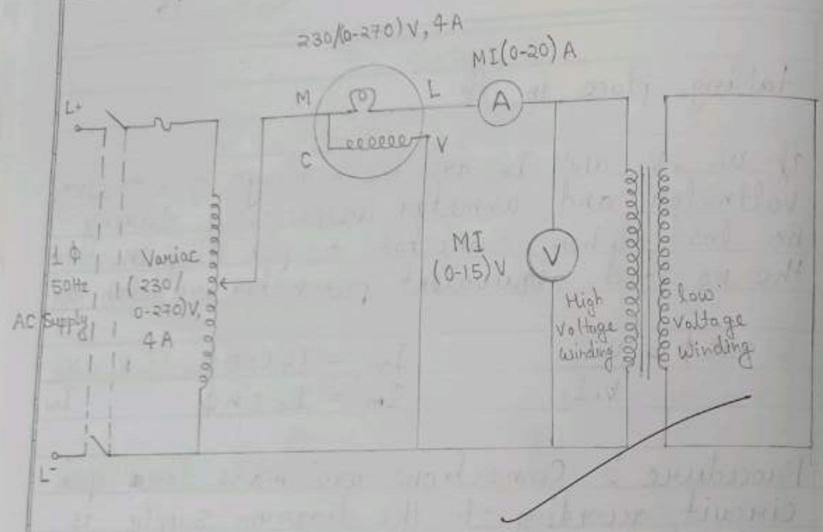
Procedure :- Connections ~~are~~ made for open circuit according to the diagram supply is switched on with variac on its min position. The voltage applied to the transformer is adjusted to its rated value. The reading of meters are recorded carefully and one set of reading corresponding to the rated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

Result :- No load equivalent parameters are -

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

$I_m = 1.092$, $I_W = 0.128$

$R_o = 1796.8\Omega$, $X_o = 210.6\Omega$



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Experiment -8

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

Instruments Required :-

S.No.	Name	Type	Range	Quantity
1.	Variac	1-ϕ	230/(0-270), 4A	1
2.	Wattmeter	–	20A, 15V	1
3.	Ammeter	MI	(0-20)A	1
4.	Voltmeter	MI	(0-15)V	1

Theory :-
One of winding of 1-ϕ transformer is short circuited. Reduced AC voltage is supplied to other winding. This voltage has to be very small usually being about 5-10% of rated value within this small value of voltage the iron loss in the transformer is negligible. Thus power input to the transformer is spent mostly to supply. The copper loss occuring in it and current flowing in primary is nearly equal to the secondary current prefered to primary scale.

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

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

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

The regulation of transformer is the change in voltage at secondary terminal from no load to full load and is expressed as 1% no load voltage.

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

$$[I_{sc} \times R_{sc} \cos\phi \pm I_{sc} . X_{sc} \sin\phi] \times 100 / V_{20}$$

I_{sc} = load current
V_{20} = No load secondary voltage prefered to primary scale
ϕ = Power factor angle of load

Efficiency of transformer is defined as the rato of output Power to the input power

$$\text{Efficiency} = \frac{\text{OutPut Power}}{\text{output Power} + \text{Iron loss} + \text{Cu loss}}$$

Observation Table :-

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

Calculations :-

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

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

$$X_{sc} = \sqrt{Z_{sc}^2 - R_{sc}^2} = \sqrt{(0.615)^2 - (0.355)^2} = 0.502\,\Omega$$

The value of losses at rated voltage is known from the no load test results.

Procedure :-

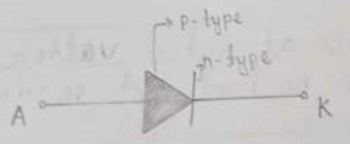
1. Connections are made for short-circuit test according to diagram.
2. It should be ensured that supply is switched on when the regulator is in its min position.
3. The voltage is adjusted so that the current flowing in short circuited winding is of rated value.
4. The reading of all the meters should be taken very carefully.

Results :-

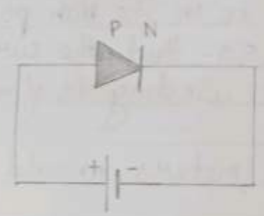
Value of Z_{sc} = 0.615 Ω

Value of R_{sc} = 0.355 Ω

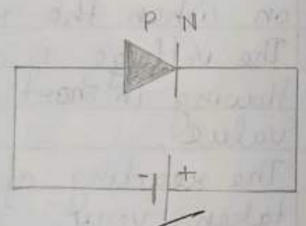
Value of X_{sc} = 0.502 Ω



(i) Circuit symbol of P-N Junction diode



(ii) Forward Biasing



(iii) Reverse Biasing

Experiment - 9

Aim :- To study the electronic devices like semi-conductor, diode, Zener diode, etc.

Theory :-

1. 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'

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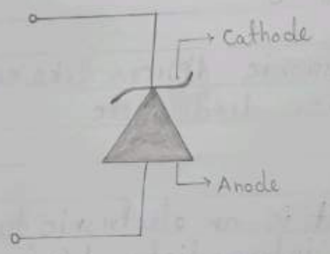
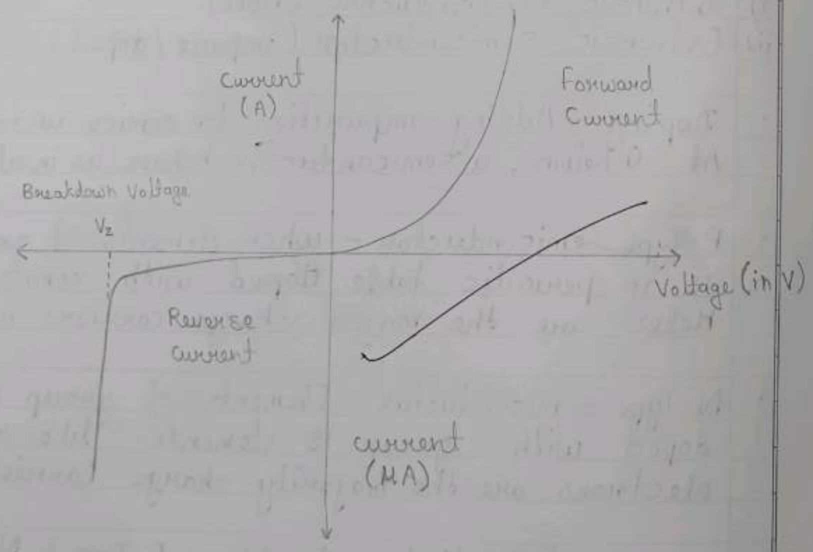


zener diode Circuit diagram



V-I Characteristics of Zener Diode

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Uses :- i) In rectifier → To convert AC to DC
ii) LCD
iii) Laser
iv) Solar cell

Biasing - when a DC voltage is applied on a device it is said to be biased.

Special Purpose Diode

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 (V_z)

On Zener region voltage across zener diode remain constant but the current changes depending on supply voltage.

* Applications :- 1) Voltage regulator
2) Meter protection

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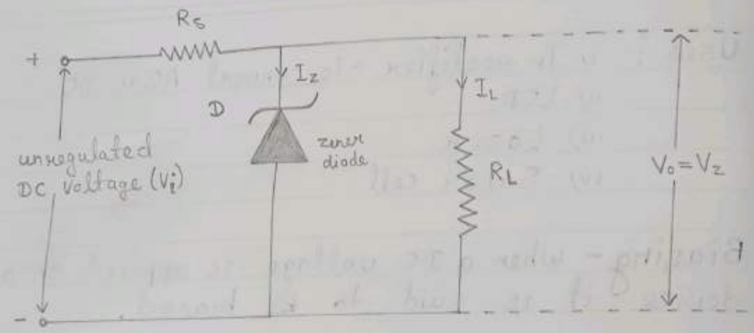
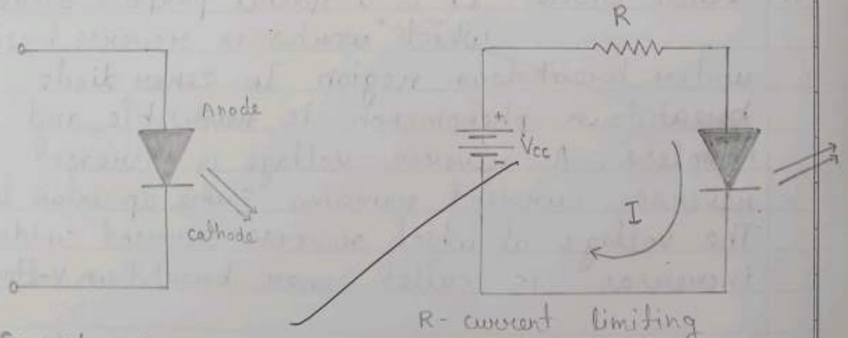


$R_S \rightarrow$ current limiting Resistor

Zener Diode as Voltage regulator



Circuit Diagram of LED

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 regulator, it can be used to provide constant voltage from source whose voltage may vary even a considerable range.

V_i is the regulated voltage source provide in input voltage. R_S - current limiting resistor. R_C - load resistor. zener diode of zener voltage (V_Z) is reverse connected across V_i. R_i 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.

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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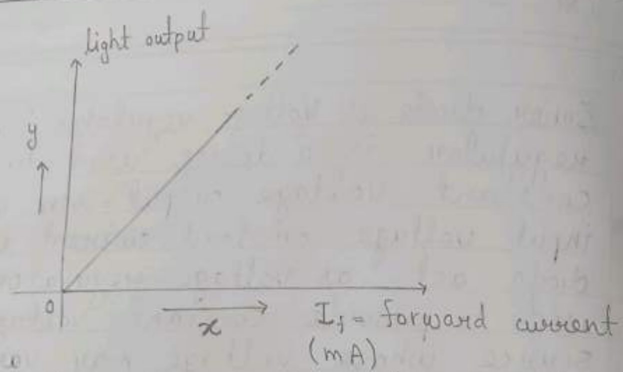
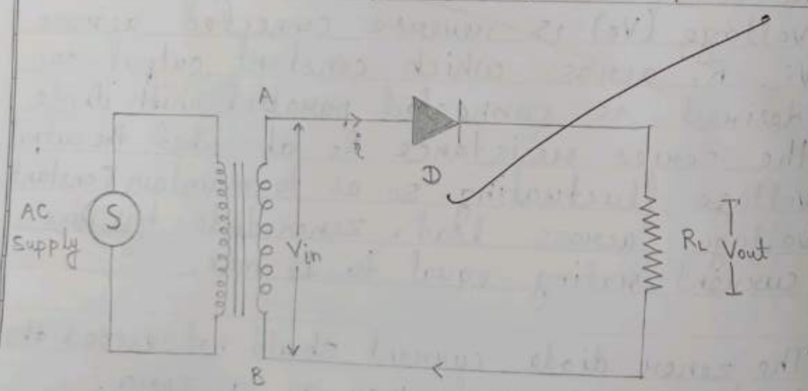


Amount of Light emitted V/s forward current

Type	V_m (V)	V_{rms} (V)	V_{DC} (V)	t (ms)	η
Half Wave	17.5	12.37	11.4	20ms	0.48



Half Wave Rectifier

Principle :- When P-N Junction diode is forward biased minority carriers flow in large number when they combine with majority carriers producing light in visible or Infrared region. The wavelength of light is given by

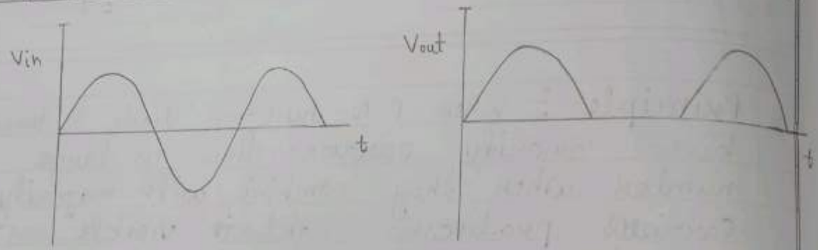
$$\lambda = \frac{hc}{E_g} = \frac{1.24}{E_g(eV)} \ \mu m$$

This is called injection electroluminense.

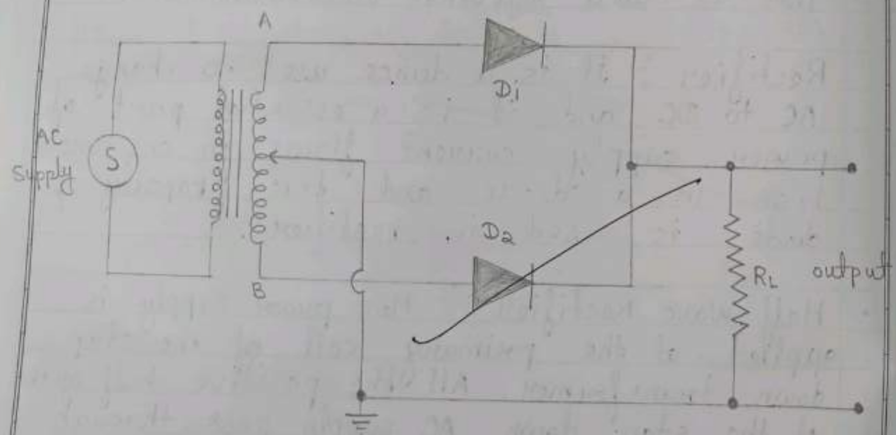
Rectifier :- It is a device used to change AC to DC and ~~it is~~ a essential part of power supply current flows in one direction in a diode and this property of diode is used in rectifier.

- 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



Operation of Half-Wave Rectifier



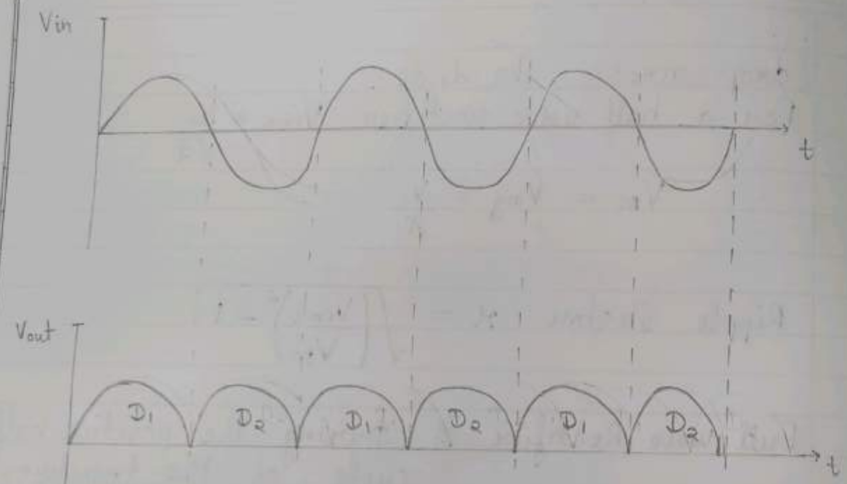
Center tapped Full-Wave Rectifier

drop across the diode.
For a half wave rectifier $V_{rms} = \frac{V_0}{\sqrt{2}}$

$$V_{DC} = V_{avg} = \frac{V_0}{\pi}$$

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

Full-Wave Rectifier : During the positive half cycle of the transformer secondary ~~voltage~~ diode D_1, is forward biased and D_2 is reversed biased current flows ~~through the D_2~~, load resistance R & lower half of the transformer winding, so the current flows through the diode D_1, load resistance & upper half of transformer winding. During the negative half cycle diode D_2 becomes forward biased and D_1 become reverse biased. The current flows through the diode D_2, load resistance R_L & lower half of the transformer winding.



Operation of full-wave rectifier

Type	Vm (V)	Vrms (V)	VDC (V)	t (mS)	r
full Wave	20 V	14.14	12.37	20mS	0.48

· 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.

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

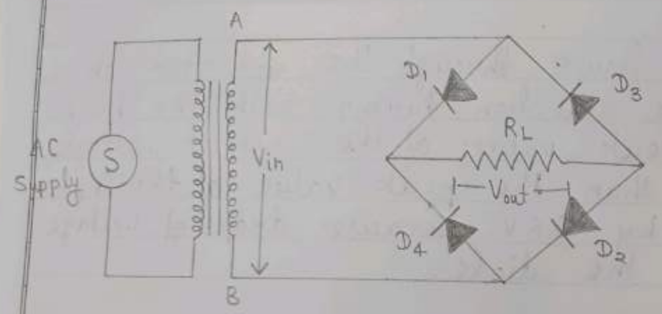
$$V_{DC} = V_{avg} = \frac{2V_0}{\pi}$$

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

Full-Wave rectifier have Two types :-
i) centre top
ii) Bridge

i) Bridge Rectifier :- During the positive half cycle of the secondary voltage diode 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

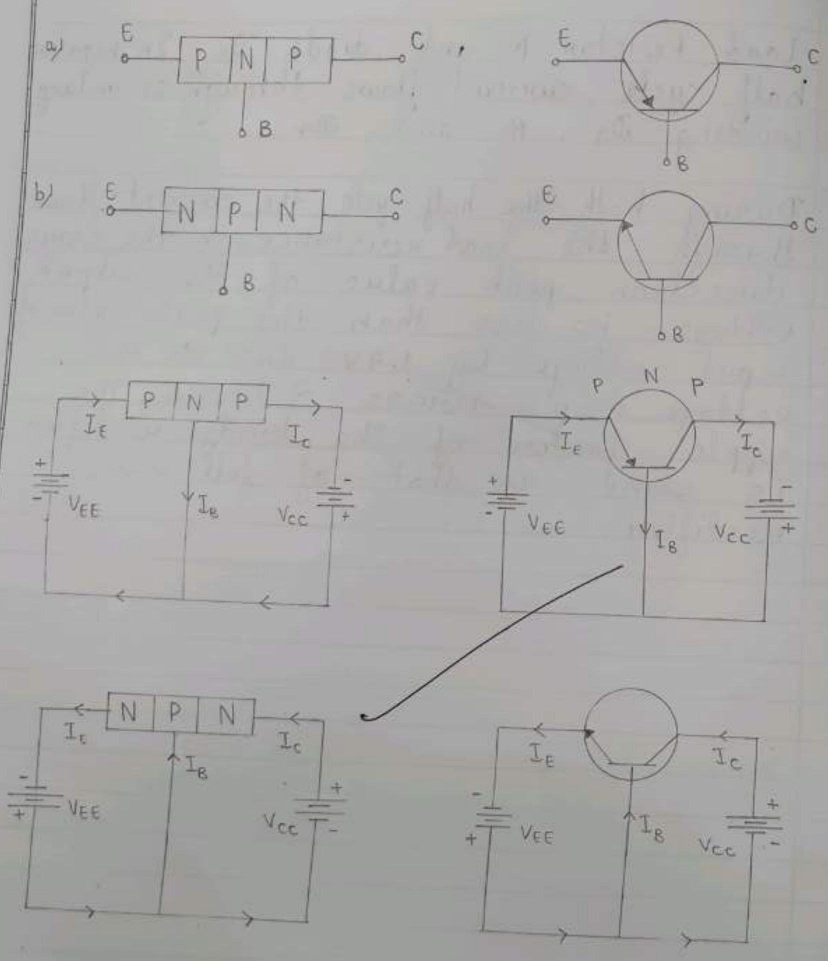


Full-Wave Bridge Rectifier

load Resistor R_L and diode D_2. In negative half cycle, current flows through secondary winding D_3, R_L and D_4.

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.

Structure Symbol



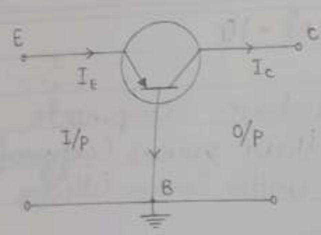
Biasing in PNP and NPN transistors

Experiment - 10

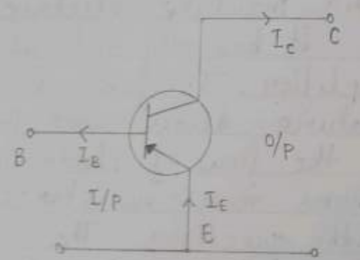
Aim :- Study of the electric components like transistor and their various Configuration (Common Base, Common emitter, Common Collector)

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 junctions. The transistors consist two P-N Junction diode connected back to back. It has three terminal 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.

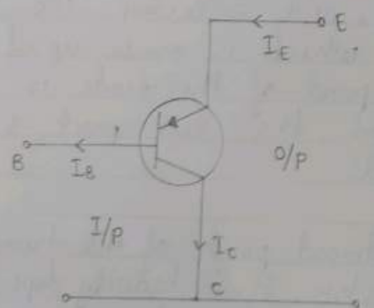
- Emitter :- It is the rightmost part of the transistor. load of the transistor. It is heavily doped. Supplies a large number of majority charge



Common-Base Configuration



Common-emitter Configuration



Common-collector configuration

carriers to the base. It is connected to base in forward bias. It is moderate in size.

- Base :- 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 :- 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 charge carriers. It is connected to base in reverse biased.

- PNP-Transistor :- 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 electron are minority.

- NPN-Transistor :- Type consist of 2 n-type semi-conductor that sandwiched with P-type.

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

Transistor Current

I_E - emmiter 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

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

$$\alpha = \frac{\Delta I_C}{\Delta I_E} \qquad \alpha = -\frac{I_C}{I_E}$$

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

2. 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

$$\alpha = \frac{I_C}{I_E} \qquad \beta = \frac{I_C}{I_B}$$

$$I_E = I_B + I_C$$

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

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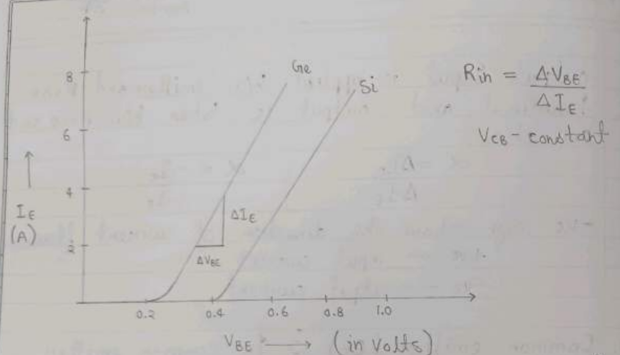
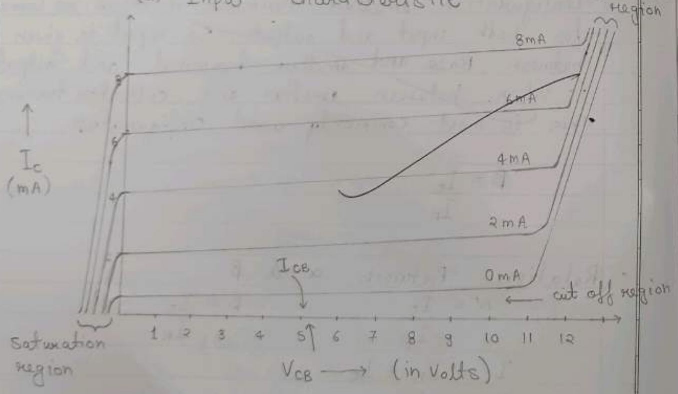


(a) Input characteristic



(b) Output characteristic

Common Base static characteristic

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

$$\boxed{\alpha = \frac{\beta}{1+\beta}} \qquad \boxed{1-\alpha = \frac{1}{1+\beta}}$$

5. Common Collector (CC) :- In CE 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 characteristics may be used to find the input resistance of transistor. Its value is given by reciprocal of its slope.

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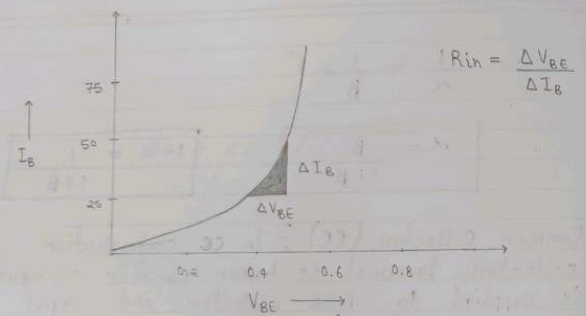
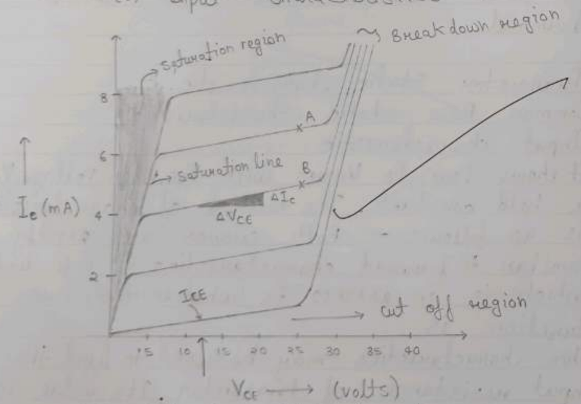


(a) Input characteristics



(b) Output Characteristics

Common - Emitter static characteristics

$$R_{in} = \frac{\Delta V_{BE}}{\Delta I_E} \longrightarrow V_{CB} \text{ constant}$$

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

Output characteristics :- It shows I_C varies with I_{CB} when I_E is held constant.

It may be seen that I_C flows even when $V_{CB} = 0$ 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 neutrilise 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 Rin of transistor

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

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 if collector Current flows when $I_B = 0$. It is called I_{CE} since main Collector current is 0. Transistor is said to be cut off.

08/02/23