I/II SEM B.Tech. ELECTRICAL ENGINEERING LABORATORY
CBCS-NEP 2020

1. Verification of KCL & KVL for DC circuits.
2. Two way / Three-way control of lamps.
3. Measurement of current, power & power factor of Fluoroscent-lamp (with & without capacitor), Incandescent lamp & LED lamp.
4. Measurement of Resistance & Inductance of a choke coil using 3 voltmeter method.
5. Magnetization characteristics of DC shunt generator.
6. Torque speed characteristics of DC motor.
7. No-load & Short circuit test on single phase transformer & pre-determine the efficiency.
8. Torque-Slip characteristics of three phase Induction motor.
9. Diode characteristics.
10. Transistor characteristics.
11. Measurement of resistance.

What is a Signal Generator: different types

The many types of signal generator are used within many test systems supplying a stimulus to the unit under test.

A signal generator is piece of test equipment that produces an electrical signal in the form of a wave. This is used as a stimulus for the item being tested.

Signal generators in all their forms are widely used within test and development systems, being used with other test instruments.

When looking at what a signal generator is, it will be seen that they come in many forms - there are many signal generator types, each one being used to provide a different form of signal. Some provide RF signals, others audio signals, some can provide different shapes of waveform and others may provide just pulses.

Signal generators have been used for many years. Early types were very basic by the standard of today's different types of signal generator. Performance levels as well as the variety of facilities that are available have increased and improved.

Summary of signal generator types

Looking at what a signal generator is, it will be seen that there are many different types of signal generator:

Arbitrary waveform generator : The arbitrary waveform generator is a type of signal generator that creates very sophisticated waveforms that can be specified by the user. These waveforms can be almost any shape and can be entered in a variety of ways, even extending to specifying points on the waveform.

Essentially an arbitrary waveform generator can be thought of as a very sophisticated function generator. Being considerably more complex, arbitrary waveform generators are more expensive than function generators, and often their bandwidth is more limited because of the techniques required in generating the signals.

Audio signal generator: As the name implies this type of signal generator is used for audio applications. Signal generators such as these run over the audio range, typically from about 20 Hz to 20 kHz and more. They are often used in audio measurements of frequency response and for distortion measurements. As a result they must have a very flat response and also very low levels of harmonic distortion.

Function generator: The function generator is a type of signal generator that is used to generator simple repetitive waveforms. Typically this signal generator type will produce waveforms or functions such as sine waves, sawtooth waveforms, square and triangular waveforms.
Early function generators tended to rely on analogue oscillator circuits that produced the waveforms directly. Modern function generators may use digital signal processing techniques to generate the waveforms digitally and then convert them from the digital into an analogue format.

Many function generators will tend to be limited to lower frequencies as this is where the waveforms created by this type of signal generator are often required. However it is possible for higher frequency versions to be obtained.

Pulse generator: As the name suggests, the pulse generator is a form of signal generator that creates pulses. These signal generators are often in the form of logic pulse generators that can produce pulses with variable delays and some even offer variable rise and fall times.

Cathode-Ray Oscilloscope (CRO) :

CRO is an electronic-display device containing a cathode-ray tube (CRT) that generates an electron beam that is used to produce visible patterns, or graphs, on a phosphorescent screen. The graphs plot the relationships between two or more variables, with the horizontal axis normally being a function of time and the vertical axis usually a function of the voltage generated by the input signal to the oscilloscope.

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Speed of response is the cathode-ray oscilloscope's chief advantage over other plotting devices. General-purpose oscilloscopes have plotting frequencies of up to 100 megahertz (MHz), or 100 million cycles per second. Response times as rapid as 2,000 MHz are achievable with special-purpose high-speed oscilloscopes.

The central component in this device, the cathode-ray tube, consists of an evacuated glass container with a phosphorescent coating at one end (similar to that of a television screen) and an electron gun and a system for focusing and deflecting the beam of electrons at the other. The electron beam emerging from the electron gun passes between pairs of metal plates mounted in such a way that they deflect the beam horizontally and vertically to control the production of a luminous pattern on the screen. The screen image is a visual representation of the voltages applied to the deflection plates. Alternatively, the beam may be deflected magnetically by varying the currents through externally mounted deflection coils. Thus, almost any graph can be plotted on the screen by generating horizontal and vertical deflection voltages or currents proportional to the lengths, velocities, or other quantities being observed.

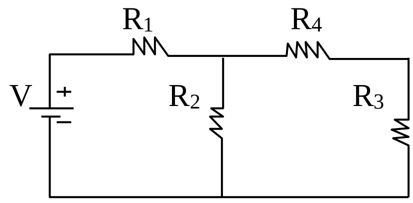
It is sometimes necessary or desirable to plot more than one waveform at the same time on the screen of an oscilloscope. With the use of a variety of techniques, four or more plots can be simultaneously shown. With a dual-trace amplifier and a single electron gun, two signals may be shown at what appears to be the same time. Actually, the amplifier electronically switches rapidly between the two observed signals. In a split-beam CRT the electron beam from a single gun is split, with the two parts receiving different vertical deflections. A dual-gun CRT uses two separate electron guns, each having its own focus and brightness controls. By combining two dual-trace amplifiers with a dual-gun CRT, four individual plots can be obtained.

The cathode-ray oscilloscope is one of the most widely used test instruments; its commercial, engineering, and scientific applications include acoustic research, television-production engineering, and electronics design.

Experiment No.1

VERIFICATION OF KCL AND KVL FOR D.C. CIRCUIT

Aim :- To verify experimentally Kirchhoff's laws for the given d.c circuit



Apparatus required :-

Sl.No.	Instrument	Range	Quantity
1.	Ammeter (D.C)	(0-2)A	03
2.	Voltmeter (D.C) or Multimeter	(0-30)V	01
3.	Resistance board	---	01

STATEMENT :

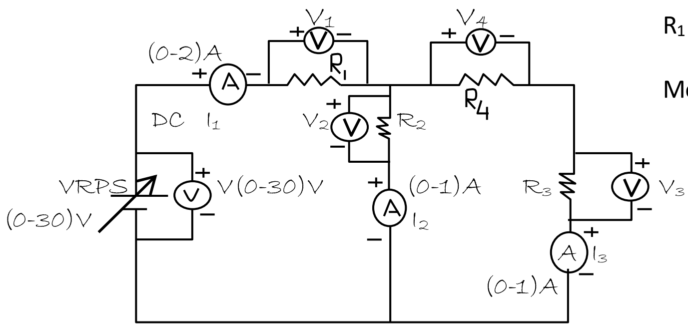
KCL :- In an electric circuit junction A, consisting of resistors and batteries, the sum of incoming currents to a junction is equal to sum of outgoing currents. $I_1 + I_2 = I_3 + I_4$ where I_1 I_2 are incoming currents and I_3 I_4 are outgoing currents.

KVL :- In a closed mesh of an electric circuit, the algebraic sum of IR drops is equal to sum of emf's in that path.

$$\pm\sum IR = \pm\sum E$$

+ indicates higher potential point and – indicates lower potential point

CIRCUIT DIAGRAM :-



V_1 , V_2 , V_3, V_4 == Voltmeter of range (0-30)V

R_1 = R_2 = R_3 = R_4 =

Measure Resistor values using multimeter

Procedure :-

(1) Connections are made as shown in circuit diagram.
(2) Keeping output of VRPS at zero position, close main supply switch.
(3) Adjust VRPS such that all the meters will read some convenient value.
(4) At each step note down the meter readings and tabulated.

K.C.L :-

I_1 Amps	I_2 Amps	I_3 Amps	$I_2 + I_3$ Amps

K.V.L :-

V volts	V_1 volts	V_2 volts	V_3 volts	V_4 volts	$V_3 + V_4$	$V_1 + V_2$

If $I_2 + I_3$ is equal to I_1 then KCL is verified.
If $V_3 + V_4 = V_2$ and $V_1 + V_2 = V$ then KVL is verified.

RESULT: KCL & KVL are verified for the given DC circuit.

Experiment No.2

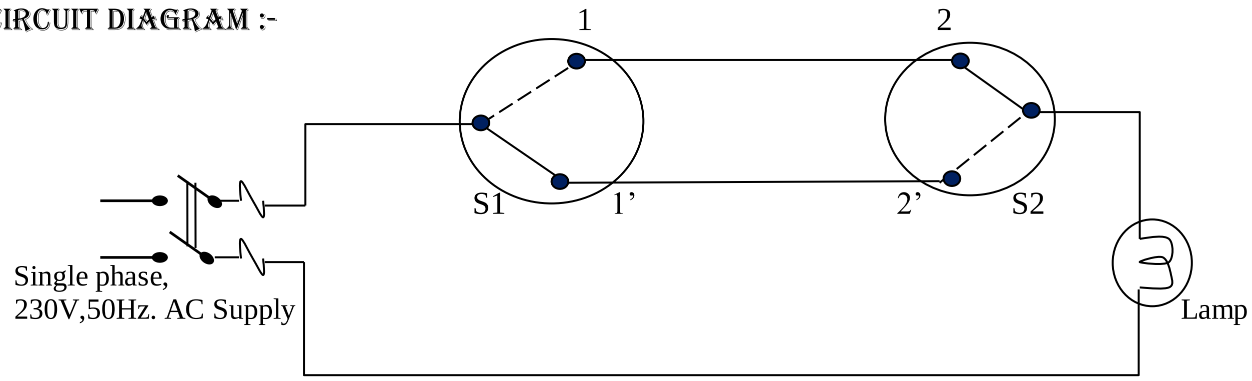
TWO WAY AND THREE WAY CONTROL OF LAMP

Aim :- To control the given lamp from two different places (Two way control) and three different places (Three way control)

APPARATUS REQUIRED :-

Sl.No.	Instrument	Range	Quantity
1.	Two way switch	----	02
2.	Switch board	----	01
3.	Lamp	40w or 100w	01
4.	Intermediate switch	----	01

CIRCUIT DIAGRAM :-



THEORY :

A light or lights can be controlled by more than one switch. The usual practice in home construction is to use Single pole switch, 2-way and 3-way switches. The Single pole switch is also called SPST switch, SPST means Single Pole Single Throw (SPST) switch.

Two way control, means having two switches in different locations to control one lamp. They are wired so that operation of either switch will control the light(s). A Two Way light switch is a simple single pole "changeover" switch with three terminals. These are typically labelled COM, 1, and 2. Or COM, 1' or 2'.

In one switch position the COM terminal is connected to 1. In the other switch position it changes over so that COM is connected to 2.

This arrangement is often found in stairways (stair case wiring) with one switch at upstairs and one switch at downstairs or in long hallways with a switch at either end.

Three way control, means having three switches in different locations to control one lamp. It consists of 2-SPST switches and 1-intermediate switch.

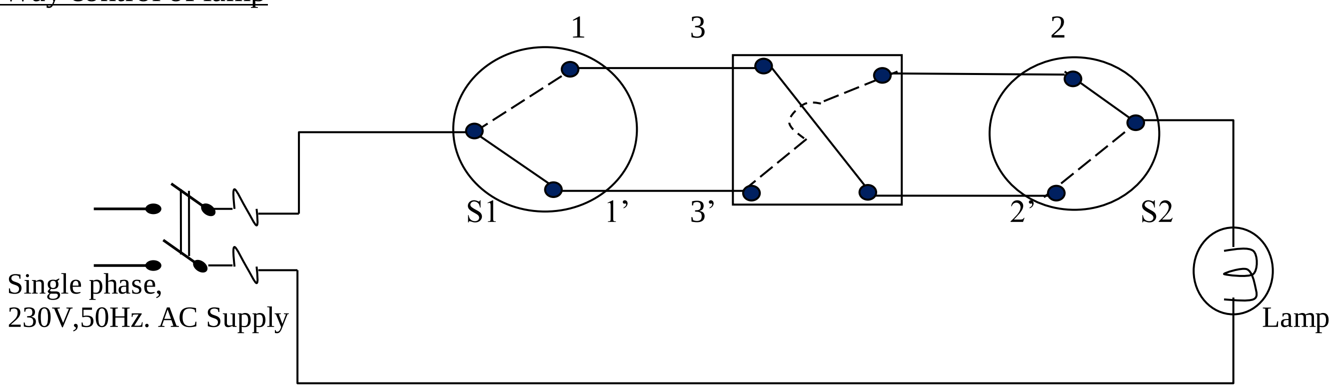
3-way control of lamp is used big godowns and in manufacturing industry where, one lamp is controlled from three different locations

PROCEDURE :-

(1) Electrical connections are made as shown in circuit diagram.
(2) Supply switch is closed. The switches S1 and S2 are put in positions 1 and 2 respectively.
(3) In each case the state of lamp whether 'ON' or 'OFF' is noted.

S1	S2	State of lamp
1	2	
1	2’	
1’	2	
1’	2’	

3 Way control of lamp



PROCEDURE :-

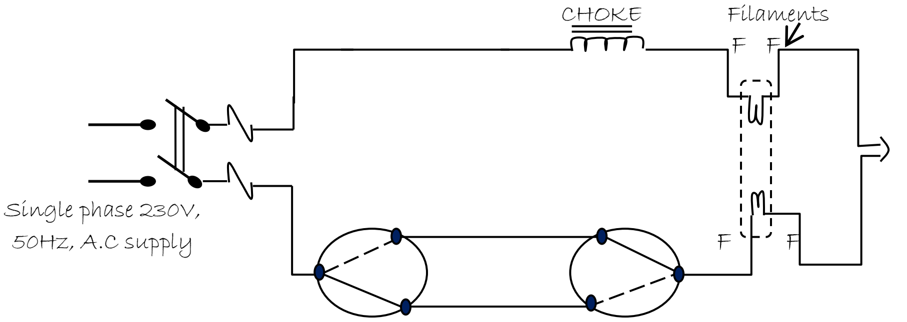
(1) Electrical connections are made as shown in circuit diagram.

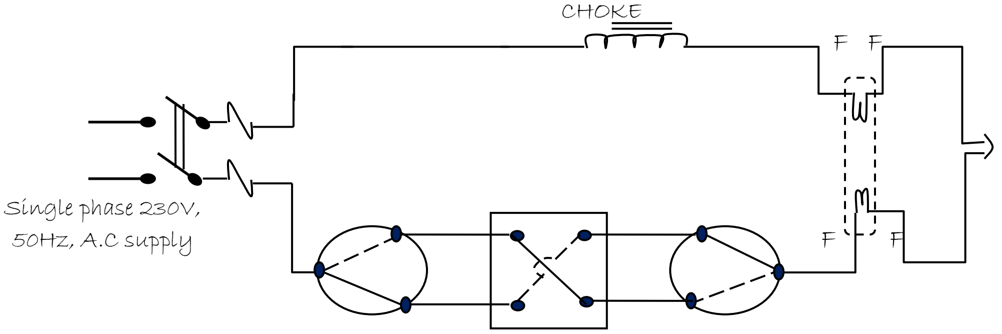
(2) Supply switch is closed. The switches S1, S2 and S3 are put in positions 11’, 22’ and 33’ respectively.

(3) In each case the state of lamp whether ‘ON’ or ‘OFF’ is noted.

S1	S2	S3	State of lamp
1	2	3	
1	2	3’	
1	2’	3	
1	2’	3’	
1’	2	3	
1’	2	3’	
1’	2’	3	
1’	2’	3’	

CIRCUIT DIAGRAM :-





S1	S2	S3	State of lamp
1	2	3	
1	2	3’	
1	2’	3	
1	2’	3’	
1’	2	3	
1’	2	3’	
1’	2’	3	
1’	2’	3’	

Experiment No.3

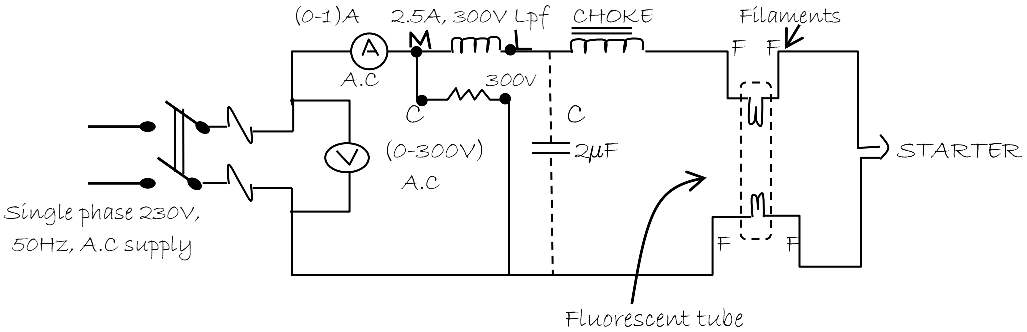
MEASUREMENT OF CURRENT, POWER AND POWER FACTOR OF FLUORESCENT LAMP (WITH & WITHOUT CAPACITOR), INCANDESCENT LAMP & LED LAMP

Aim :- To measure power and power factor of Fluorescent lamp with /without capacitor

APPARATUS REQUIRED :-

Sl.No.	Instrument	Range	Quantity
1.	Ammeter (A.C)	(0-1)A	01
2.	Voltmeter (A.C)	(0-300)V	01
3.	Wattmeter	2.5A, 300V, LPf	01
4.	Capacitor	2µF	01

CIRCUIT DIAGRAM :-



THEORY :-

Working of the Fluorescent Tube Light:

The fluorescent lamp circuit consists of a choke, a starter, a fluorescent tube and a frame. The length of the commonly used fluorescent tube is 100 cm, its power rating is 40 W or 36 W and 230V. The tube is filled with argon and a drop of mercury.

When the supply is switched on, the current heats the filaments and initiates emission of electrons. After one or two seconds, the starter circuit opens and makes the choke to induce a momentary high voltage surge across the two filaments. e = L. di/ dt. Where L is the inductance of Choke coil and di/dt is created by starter. Ionization takes place through argon and produces bright light.

When capacitor is not connected along with the accessories, the power factor of the circuit is around 0.5 to 0.6. When capacitor is connected in the circuit, because of leading current supplied by capacitor the total current drawn by the circuit is reduces. The power factor is improved to 0.65 to 0.7. We say that the capacitor improves the pf of the circuit.

PROCEDURE :-

(1) Electrical connections are made as shown in circuit diagram.

(2) Main supply switch is closed and readings of all meters are noted down.

(3) Power factor of the circuit is calculated using the formula

$$\text{Cos}\varphi = \text{pf} = \frac{W}{V\,I} = \frac{\text{Wattmeter Reading}}{\text{Voltmeter reading x Ammeter reading}}$$

(4) Above procedure is repeated for with capacitor.

To calculate Wattmeter constant

$$\text{K= Wattmeter constant} = \frac{V_{rated} \times I_{rated} \times \text{Cos}\,\emptyset}{\text{Maximum scale deflection}}$$

V_{rated} = Potential coil rating, I_{rated} = Current coil rating
$\cos\varphi$ = Power factor (= 1 for u.p.f)
(=0.2 for Lpf as indicated)

Tabular column :-

Voltmeter reading V	Ammeter reading I	Wattmeter reading W	p.f	
				Without capacitor
				With capacitor

Results :-

(1) Real power consumed = W= __________ watts
(2) p.f. with C = ______________
p.f without C = ___________

Experiment No.4

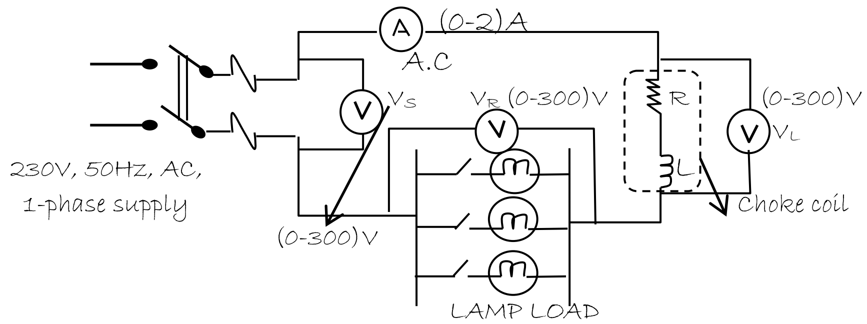
MEASUREMENT OF RESISTANCE & INDUCTANCE OF A CHOKE COIL USING 3 VOLTMETER METHOD

AIM :- To determine the Inductance, resistance and power factor of given choke coil by 3-voltmeter and one ammeter method.

APPARATUS REQUIRED :

Sl.No.	Instruments	Range	Quantity
1.	Ammeter (A.C)	(0-2)A	01
2.	Voltmeter (A.C)	(0-300)V	03

CIRCUIT DIAGRAM :-



THEORY:

The inductance is the property of an electric conductor or circuit that cases an electromotive force to be generated by a change in the current flowing. Inductance is the tendency of electric conductor to oppose a change in electric current flowing through it. The flow of electric current creates a magnetic field around the conductor. The field strength depends on the magnitude of the current. There are two types of inductance are defined in electric circuit, self inductance and mutual inductance. Self induction is the phenomenon in which a change in electric current in a coil produces an induced emf in the coil itself. The mutual inductance is the characteristics of a pair of coils. The inductance of the coil depends on number of turns, type of material and the core.

PROCEDURE :-

(1) Electrical connections are made as shown in circuit diagram.
(2) Keeping lamp load switches off, close the main supply switch.
(3) Apply the load in steps and at each step note down the readings of all meters and tabulated.
(4) Switch off all the lamps, open the supply switch.

TABULAR COLUMN :-

Trial No.	I Amps	V_S Volts	V_L Volts	V_R Volts	Cos ϕ p-f	X_L Ω	L Henry	R Ω
1								
2								

CALCULATIONS :-

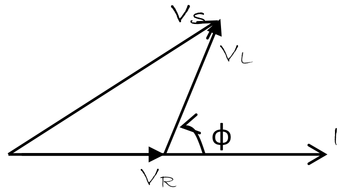
Power factor = $\cos\phi = \frac{V_S^2 - V_R^2 - V_L^2}{2 V_R V_L}$ $Z = \frac{V_L}{I} = \Omega$

$X_L = Z\sin\phi =$ ________ Ω $R = Z\cos\phi =$ ________ Ω

$L = \frac{X_L}{2\pi f} = \frac{X_L}{2 \times \pi \times 50} =$__________ H

VECTOR DIAGRAM :-

I as reference vector, V_R is in-phase with **I**. V_L leads **I** by **ϕ**°.
V_S is vectorial sum of V_R and V_L.



RESULT :- Inductance of given choke coil = ________ Henry
Resistance of given choke coil = ______ Ω

Experiment No.5

MAGNETIZATION CHARACTERISTICS OF DC SHUNT GENERATOR
O.C.C OF D.C SHUNT GENERATOR (SAPERATELY EXICTED)

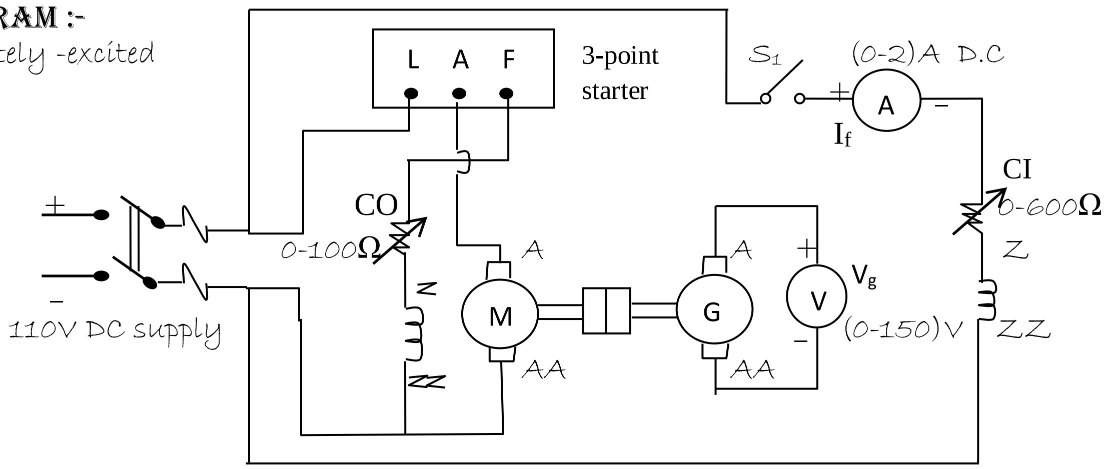
AIM :- To draw the open circuit characteristics (OCC) of D.C. shunt generator, and hence to calculate the critical field resistance (R_C).

APPARATUS REQUIRED :

Sl.No.	Instruments	Range	Quantity
1.	Ammeter D.C	0-2A	01
2.	Voltmeter D.C	0-150V	01

CIRCUIT DIAGRAM :-

O.C.C of separately -excited dc generator



Name plate details	
Motor	Generator
Rated V=110V	110V
Rated I =18.2	18.2
Kw = 2	2
Rated speed =1500 rpm	1500 rpm

THEORY :-

The critical field resistance is defined as the maximum field circuit resistance, for a given speed with which the shunt generator would excite. Shunt generator will build up voltage only if field circuit resistance is less than critical field resistance R_C. There are some conditions must be fulfilled for building up of voltage in a DC generator. They are (a) Poles should contain some residual flux (residual voltage) (b) Resistance of field winding must be less than critical resistance R_C. (c) Field and armature winding must be correctly connected so that initial mmf adds residual flux. Open circuit characteristics is also known as Magnetic characteristics. This characteristics shows the relation between generated emf at no load V_0 and field current I_f at a given fixed speed. Field current is gradually increased and the corresponding terminal voltage is recorded.

PROCEDURE :-

(1) Note down the name plate details of motor and generator.
(2) The Electrical connections are made as shown in circuit diagram.
(3) The Rheostat 0-100Ω is kept in cut-out position. The Rheostat 0-600Ω connected in series with field winding of DC generator is kept at cut-in position. Main supply switch is closed.
(4) 3-point starter arm is moved from left to right gradually. During this motor increases its speed.
(5) Motor speed is adjusted to rated value by cutting in 100Ω rheostat.
(6) Reading of voltmeter V_g is noted. This is called residual voltage (This value varies from 5 to 12V).
(7) Now SPST switch S_1 is closed and readings of Ammeter (I_f) and Voltmeter (V_g) are noted down.
(8) The rheostat 600Ω is gradually cut-out in steps and at each step, ammeter and voltmeter readings are noted and tabulated.
(9) The procedure is continued till 110% of rated voltage of generator is obtained in the voltmeter.

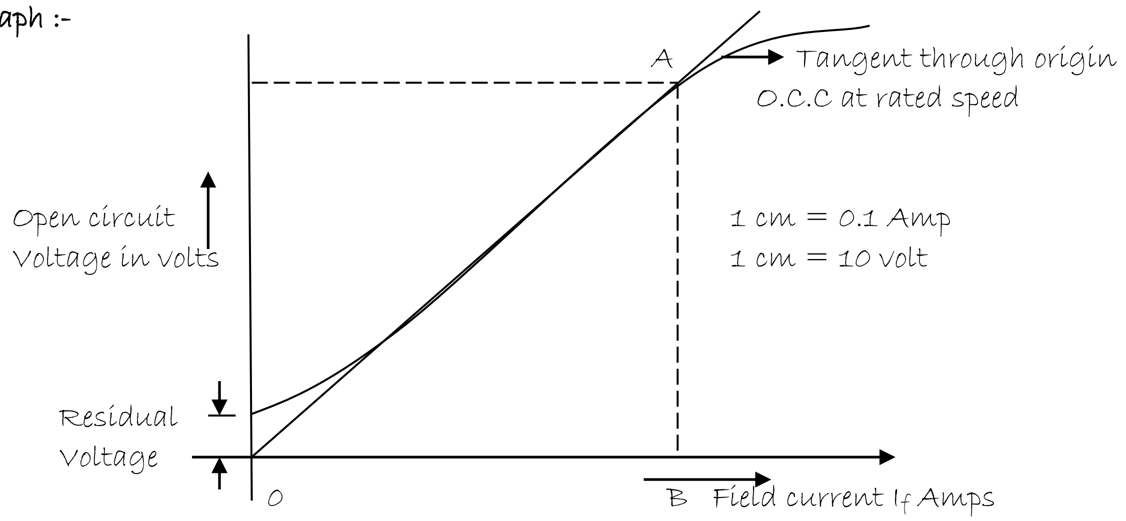
TO STOP THE MACHINE

(10) The 600Ω rheostat is brought back to cut-in position.
(11) 100Ω rheostat is brought back to cut-out position and open the supply switch.
(12) A graph of voltmeter reading (in Y-axis) and ammeter reading (on x-axis) is drawn. This is the OCC or no-load characteristics of dc shunt generator.
(13) To determine the critical field resistance, a tangent is drawn to the OCC through the origin. The slope of this line gives the value of critical field resistance R_C.

Tabular column :-

V_g OC voltage							110V	120V
I_f in Amps field current	0							

Graph :-



R_C = Critical field resistance

$R_C = \frac{AB\ in\ volts}{OB\ in\ Amps}$ = ______________ ohms

Result:- The critical Field resistance of the given dc generator is ______________.

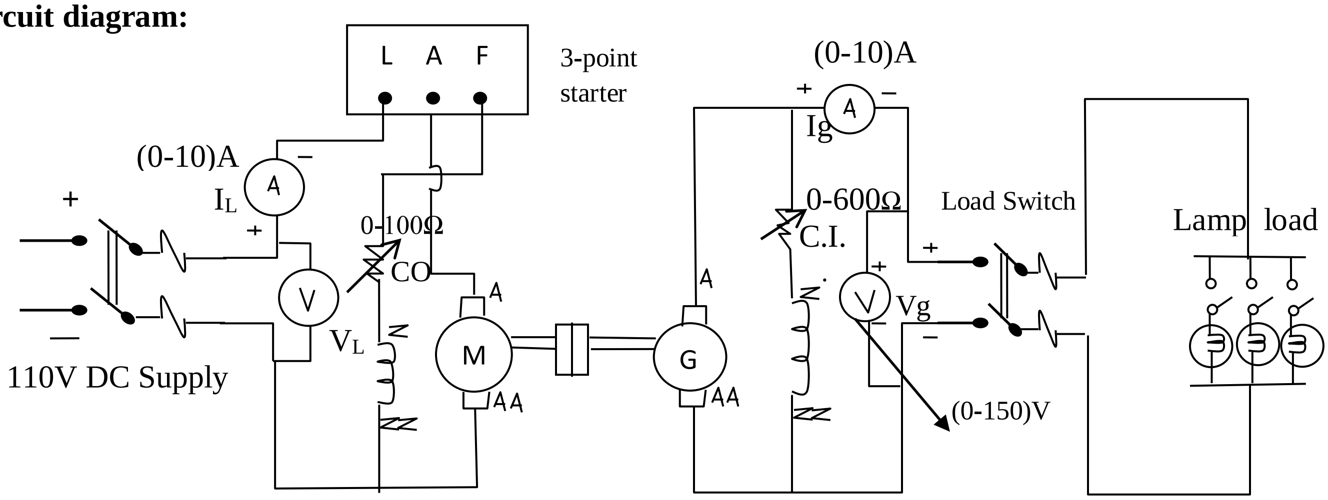
Experiment No.6: TORQUE – SPEED CHARACTERISTICS OF D.C. SHUNT MOTOR

Aim: To conduct load test on D.C shunt motor and to plot speed v/s output, torque v/s output and torque v/s speed characteristics.

Apparatus required:

Sl.No.	Instruments	Range	Quantity
1.	Ammeter DC	0-10/20A	01
2.	Voltmeter DC	0-150V	02

Circuit diagram:



Name plate details	
Motor	Generator

Theory: D.C. motor converts electrical energy into mechanical energy. It works on "whenever a current carrying conductor is placed in a magnetic field, it experiences a mechanical force". The emf induced in armature conductors is called back emf. The induced emf acts in opposite direction to the applied voltage as per Lenz's law and is known as back emf E_b. The variation of output, torque and speed for D.C shunt motor is analyzed by performance characteristics. For shunt motor flux is practically constant hence torque is directly proportional to armature current. As the mechanical load increases on the motor the speed of the motor decreases. Even though the flux is constant, as the output increases the torque of D.C. motor is also increases.

Procedure:

1. Name plate details of motor and generator are noted down.
2. Electrical connections are made as shown in circuit diagram.
3. Motor field circuit resistance 100Ω is kept in cut-out position. Generator field circuit resistance 600Ω is kept in cut-in position.
4. Keeping load switch open, main supply switch is closed.
5. 3-point starter arm is moved from left to right gradually. During this, motor increases its speed.
6. Motor speed is adjusted to rated value by cutting-in 100Ω rheostat. No-load readings are noted down (Ig = 0, Vg=8-10V, N=1500rpm).
7. D.C generator field circuit resistance is gradually cut-out, so that it develops rated voltage.

8. Load switch is closed and load is applied in steps, for each load the readings of Ammeters, Voltmeter and speed of the motor are noted and tabulated.
9. Load is increased till the ammeter (I_L) reads rated current of D.C. motor.

10. To stop the machine:
    Load switches are off. 600Ω rheostat is brought back to cut-in position, open load switch. 100Ω is brought back to cut-out position. Then switch off 110V D.C. supply switch.

Tabular column:

Sl.No.	V_L volts Supply voltage	I_L Amps Motor current	Speed rpm N	Vg volts Generator terminal voltage	Ig Amps Generator current	Input watts	Output watts	Torque kg-m
1								
2								
3								
4								
5								
6								

Specimen calculations for Trial No.2

Input = V_L x I_L = _______ watts

$$\text{Output} = \frac{\text{Vg x Ig}}{0.85} \text{ (Assuming 85\% efficinecy for D.C. Generator)} = \_\_\_\_\text{watts}$$

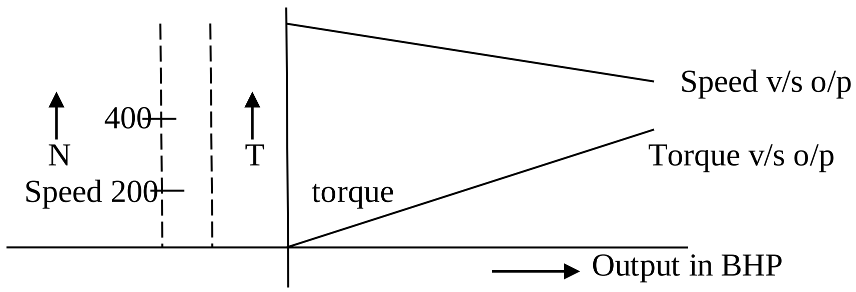
$$\text{Torque} = \frac{\text{Output x 60}}{2\pi N} = \_\_\_\_\_ \text{ Nm}$$

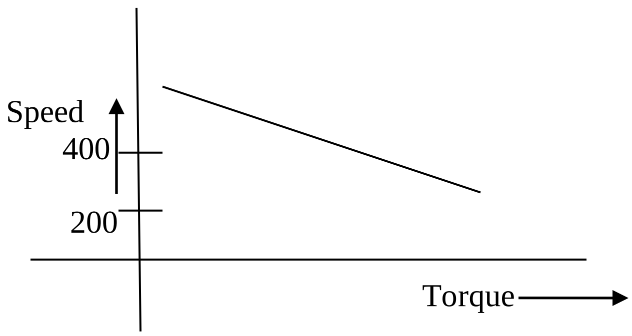
N—Speed in rpm

$$\text{Output in H.P} = \frac{\text{Output in watts}}{735.5} = \_\_\_\_\_ \text{ H.P.}$$

Performance Characteristics:

All the curves will be down in the same graph sheet.





Conclusion and Remarks: From the experimental results, as the output increases speed decreases and torque increases. From speed v/s torque characteristics it is observed that as the speed increases the torque of dc motor decreases.

Experiment No.7

NO-LOAD & SHORT CIRCUIT TEST ON SINGLE PHASE TRANSFORMER & PRE-DETERMINE THE EFFICIENCY

OPEN CIRCUIT AND SHORT CIRCUIT TEST ON SINGLE PHASE TRANSFORMER (O.C AND S.C TEST ON SINGLE PHASE TRANSFORMER)

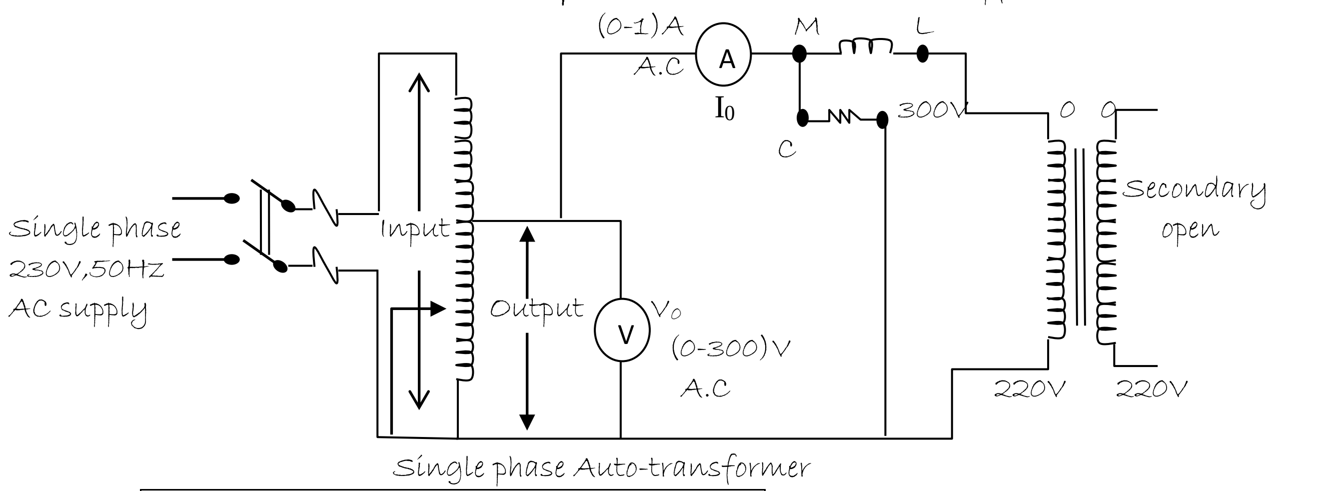
AIM :- To conduct O.C and S.C tests on given single phase transformer hence to predetermine the % efficiency.

APPARATUS REQUIRED :

Sl.No.	Instruments	Range	Quantity
1.	Ammeter AC	0-2.5A 0-10A	01 01
2.	Voltmeter AC	0-300V 0-30V	01 01
3.	Wattmeter	1.5A, 300V Lpf 10A,75V upf	01 01

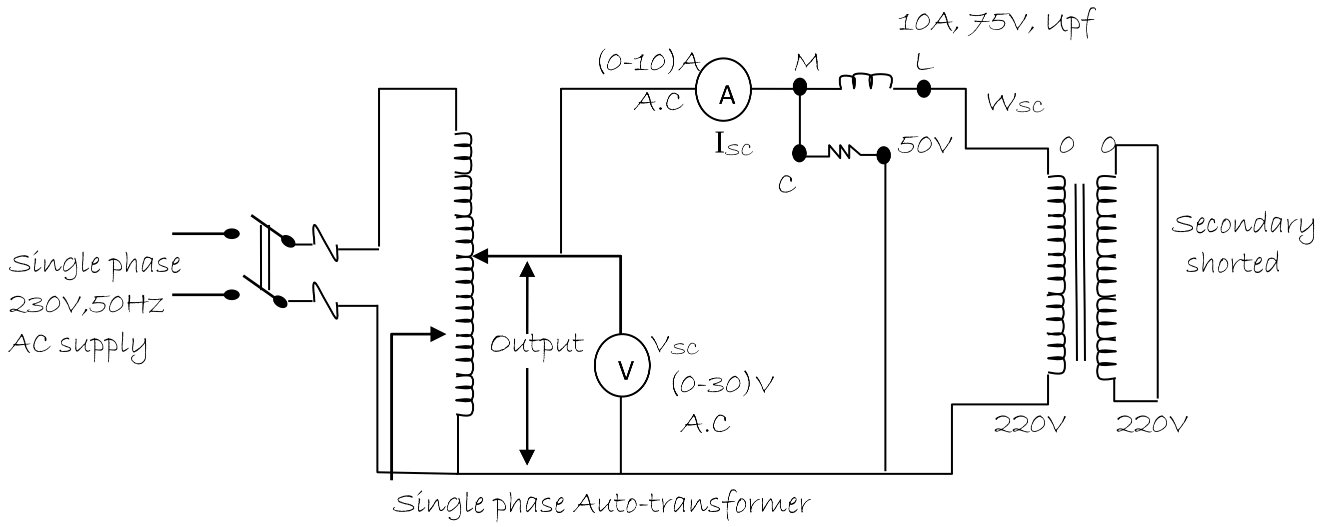
CIRCUIT DIAGRAM :-

Open circuit test



Name plate details of 1- phase transformer
1ϕ, 220V / 220V, 2KVA, Shell type , 50Hz

Short circuit test



TABULAR COLUMN :-

O.C TEST

Ammeter reading I_0	V_0 volts	W_0 x K watts (K = wattmeter constant)
	220V	

S.C TEST

I_{SC} Amps	V_{SC} volts	W_{SC} x K watts (K = wattmeter constant)
9.1		

THEORY:

Open Circuit Test on Transformer- A voltmeter, wattmeter, and an ammeter are connected in LV side of the transformer for open circuit test. The voltage at rated frequency is applied to that LV side with the help of a auto-transformer. The HV side of the transformer is kept open. Now with the help of auto-transformer, applied voltage gets slowly increased until the voltmeter gives reading equal to the rated voltage of the LV side.

As no load current is quite small compared to rated current of the transformer, the voltage drops due to this current can be neglected. Since voltmeter reading can be considered equal to the secondary induced voltage of the transformer, wattmeter reading indicates the input power during the test. As the transformer is open circuited, there is no output, hence the input power here consists of core losses in the transformer. But as said earlier, the no-load current in the transformer is quite small compared to the full load current so, we can neglect the copper loss due to the no-load current. Hence, the wattmeter reading is equal to the core losses in the transformer.

Short circuit test on transformer- A voltmeter, wattmeter, and an ammeter are connected in HV side of the transformer. The LV side of the transformer is short circuited. The voltage at rated frequency is applied to that HV side with the help of auto-transformer gradually and carefully. Now with the help of auto-transformer applied voltage is slowly increased until ammeter gives reading equal to the rated current of the HV side. As the voltage applied for full load current in short circuit test on transformer is quite small compared to the rated primary voltage of the transformer, hence the core losses in transformer can be taken as negligible.

As we have short-circuited the transformer, there is no output; hence the input power consists of copper losses in the transformer only. Since the applied voltage V_{sc} is short circuit voltage in the transformer and hence it is quite small compared to the rated voltage, so, we can neglect the core loss due to the small applied voltage. Hence the wattmeter reading can be taken as equal to full load copper losses in the transformer.

PROCEDURE :-

O.C TEST

(1) Connections are made as shown in circuit diagram.
(2) Keeping the output of auto transformer at zero volt, close the main supply switch.
(3) Vary the auto transformer such that voltmeter reads rated voltage of primary of single phase transformer.
(4) Note down all meter readings.
(5) Reduce output of auto transformer to zero volt and open the supply switch.

S.C TEST

(1) Connections are made as shown in circuit diagram.

(2) Keeping the output of auto transformer at zero volt, close the main supply switch.

(3) Auto transformer is carefully and gradually adjusted such that full load current passes through the primary winding.

Full load primary current is given by $I_1 = \frac{KVA \times 1000}{Rated\ primary\ voltage} = \frac{2 \times 1000}{220}$ Amps = 9.1 Amps

(4) Reduce output of auto transformer to zero volt and open the supply switch

Calculation of % Regulation (only S.C data is required)

Full load primary current = $I_1 = \frac{KVA \times 1000}{Rated\ primary\ voltage} = \frac{2 \times 1000}{220} =$ ________Amps

Rated primary voltage = V_1 = 220V

Impedance of Transformer referred to primary = $Z_1 = \frac{V_{SC}}{I_{SC}}\Omega =$ _______ Ω

Resistance of Transformer referred to primary = $R_1 = \frac{W_{SC}}{I_{SC}^2} =$ _________ Ω

Reactance of Transformer referred to primary = $X_1 = \sqrt{Z_1^2 - R_1^2} =$ __________ Ω

Power factor at which % regulation is required = Cos ϕ = 0.8

Therefore $\phi = \cos^{-1}(0.8) =$ _______________ Sinϕ = __________________

To predetermine the % efficiency (both O.C and S.C datas are required)

W_{SC} = Full load copper loss = __________ watts

W_o = Iron loss = core loss = _________ watts

Let 'x' be the fraction of full load at which efficiency is required.
(Lag or lead, no change in efficiency)

Copper loss at "x" = $x^2 \times W_{sc}$

Output of transformer = KVA x 1000 x "x" x Cos ϕ = ___________ watts

Total losses = $W_o + x^2 W_{SC}$

$$\%\eta = \%\ efficiency = \frac{x\ (KVA \times 1000 \times \cos\emptyset)}{x\ (KVA \times 1000 \times \cos\emptyset) + W_0 + x^2 W_{SC}} \times 100 = \frac{output\ in\ watts}{Input\ in\ watts} \times 100$$

Cos ϕ = 0.8, x =1 (for full load)

$$\%\eta = \frac{(KVA \times 1000 \times 1 \times 0.8)}{(KVA \times 1000 \times 1 \times 0.8) + W_0 + 1^2 W_{SC}} \times 100 =$$

Cos ϕ = 1, x =1/2 (for half full load)

$$\%\eta = \frac{(KVA \times 1000 \times \frac{1}{2} \times 1)}{(KVA \times 1000 \times 1/2 \times 1) + W_0 + (1/2)^2 W_{SC}} \times 100 =$$

Cos ϕ = 0.8, x =1/4 (for quarter full load)

$$\%\eta = \frac{(KVA \times 1000 \times \frac{1}{4} \times 0.8)}{(KVA \times 1000 \times 1/4 \times 0.8) + W_0 + (1/4)^2 W_{SC}} \times 100 =$$

Load X	% η
1	
0.5	
0.25	

Results :-

(a) % efficiency of transformer at 0.8 pf, full load =
(b) % efficiency of transformer at 0.8 pf, half load =
(c) % efficiency of transformer at 0.8 pf, 1/4th load =

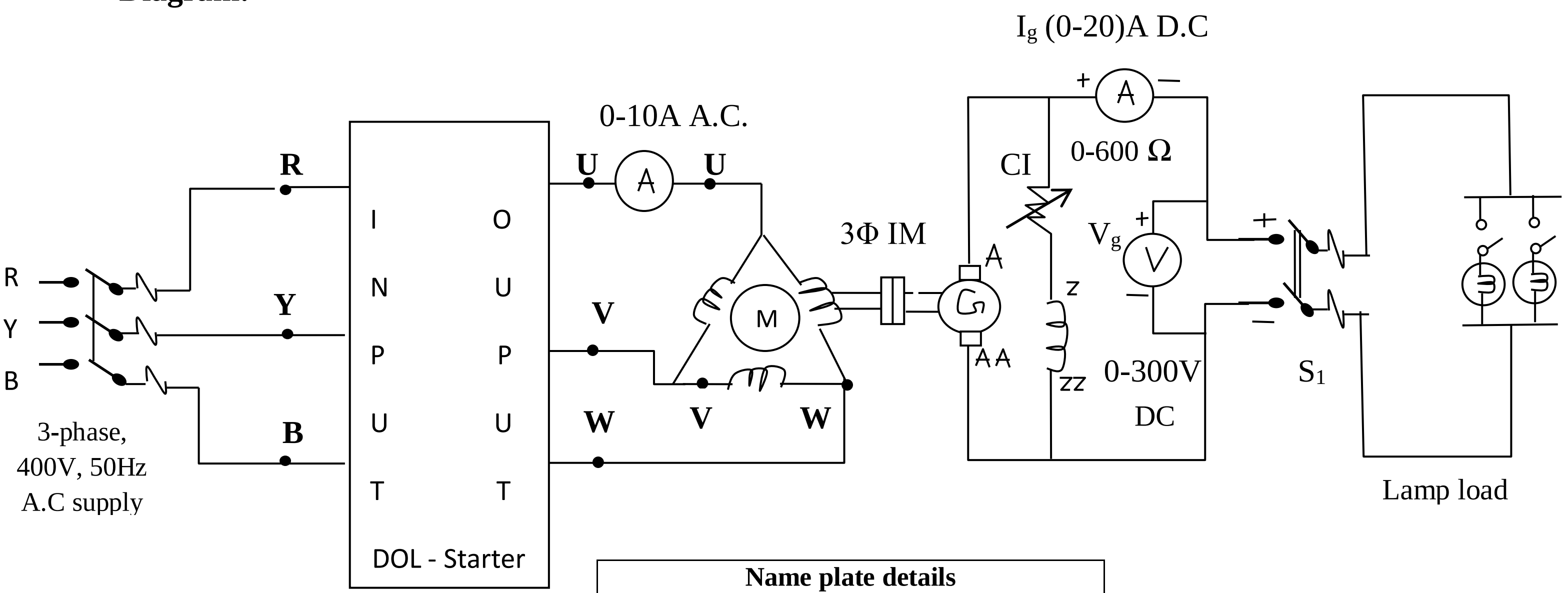
Experiment No.8: TORQUE – SLIP CHARACTERISTICS OF 3-PHASE INDUCTION MOTOR

Aim : To plot %slip v/s output, torque v/s output and torque v/s slip of given 3-phase induction motor by conducting load test.

Apparatus :

Sl.No.	Instruments	Range	Quantity
1.	Ammeter AC	0-10A	01
2.	Ammeter DC	0-10A	01
3.	Voltmeter DC	0-300V	01

Diagram:



Name plate details	
3 phase Induction Motor	D C Generator
3.7kW	3kW
5HP	220V
7 Amps	1500 rpm
1400 rpm	13.6A

Theory: A 3-phase induction motor consists of stator and rotor with the other associated parts. In the stator, a 3-phase winding is provided. The windings of the three phase are displaced in space by 120º. A 3-phase current is fed to the 3-phase winding. These windings produce a resultant magnetic flux and it rotates in space like a solid magnetic poles being rotated magnetically. The magnetic field cuts the rotor conductors inducing electromotive forces which circulate currents in them.

To obtain the performance characteristics of 3-phase induction motor, a d.c. generator is coupled to shaft of induction motor. In this experiment self-excited d.c. shunt generator is used. The d.c generator is loaded by means of electrical loading at rated voltage. At each loading all the meter readings and speed of the induction motor is noted.

As the load on the 3-phase induction motor increases the output torque is also increases but speed of the motor decreases. The torque slip curve for an induction motor gives the information about the variation of torque with the slip. The slip is defined as the ratio of difference of synchronous speed and actual rotor speed to the synchronous speed of the machine. The variation of slip can be obtained with the variation of speed that is when speed varies the slip will also vary and the torque corresponding to that speed will also vary.

As the induction motor is loaded from no load to full load, its speed decreases hence slip increases. Due to the increased load, motor has to produce more torque to satisfy load demand. The torque depends on slip.

The behaviour of motor can be easily judged by sketching a curve obtained by plotting torque produced against slip of induction motor. The curve obtained by plotting torque against slip from s = 1 (at start) to s = 0 (at synchronous speed) is called torque-slip characteristics of the induction motor.

Procedure :

1. Connections are made as shown in circuit diagram.
2. Generator field circuit resistance 600 ohms is kept in cut-in position (maximum) and switch s1 is kept open.
3. Main supply switch is closed.
4. 3-phase induction motor is started by means of starter and No-load readings are noted down.
5. Now, 600 ohm rheostat is varied such that voltmeter reads rated voltage 220V of generator.
6. Lamp load is switched on step-by-step, and at each step all the meter readings and speed of the motor is tabulated.
7. Above procedure is repeated until rated current of induction motor is reached.
8. <u>To stop the motor</u>
    - load current is reduced to zero.
    - 600 ohm rheostat is brought back to cut-in position.
    - Switch s1 is open.
    - Starter is switched off.
    - Main supply switch is opened.

Sl. No.	Motor current I_m Amps	Vg volts	Ig Amps Generator current	N speed rpm	Output watts	Torque N-m	% slip
1.							
2.							
3.							
4.							

Specimen calculations for Sl.No.2

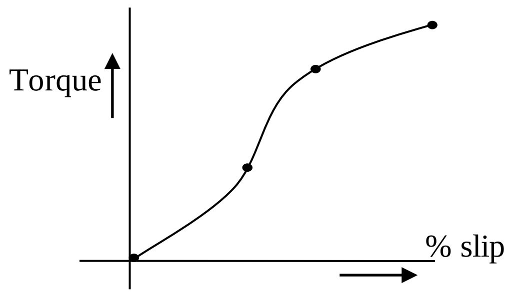
$\text{Output of } 3-\text{ph I.M} = \frac{V_g I_g}{0.85} \text{ watts}$ (Assuming 85% as efficiency of D.C. Generator)

$\text{Torque} = \frac{\text{Output x } 60}{2\pi N} \text{ Newton} - \text{meter}$

N—Speed in rpm

$\% \text{ slip} = \frac{N_s - N}{N_s} \text{ x } 100$ $N_S = 120 \text{ x } 50 / 4 = 1500$ rpm

$N_s = \frac{120f}{P}$ f = 50Hz P = No. of poles= 4.



Experiment No.9:

STATIC CHARACTERISTICS OF SEMICONDUCTOR DIODE

AIM :- To draw the **V-I** characteristics curves for a given Semiconductor diode.

APPARATUS REQUIRED :

Sl.No.	Instruments	Range	Quantity
1.	Regulated power supply	(0-30)V	01
2.	Ammeter (D.C)	(0-100)mA (0-500)µA	01 01
3.	Multi meter	----	01
4.	Diode	BY 127 OA 79	01

CIRCUIT DIAGRAM :-

FORWARD BIAS

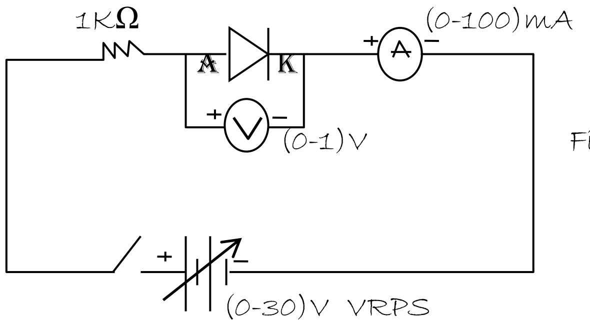


Fig (1)

REVERSE BIAS

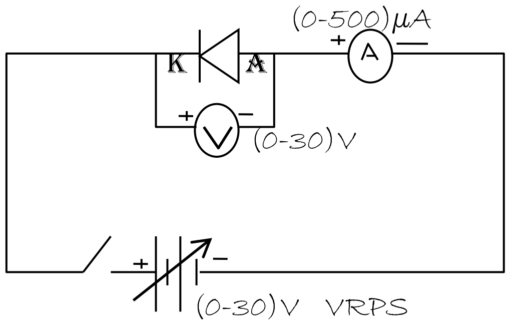
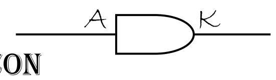


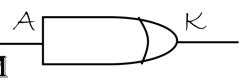
Fig (2)

BY127



SILICON

OA 79



GERMANIUM

THEORY:

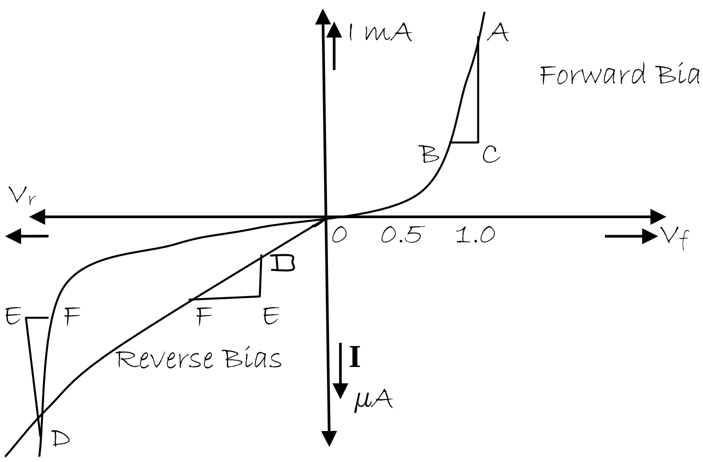
A PN Junction Diode is one of the simplest semiconductor devices and which has the characteristic of passing current in only one direction only. However, unlike a resistor, a diode does not behave linearly with respect to the applied voltage as the diode has an exponential current-voltage (I-V) relationship.

When a diode is connected in a Forward Bias condition, a negative voltage is applied to the N-type material and a positive voltage is applied to the P-type material. If this external voltage becomes greater than the value of the potential barrier, approx. 0.7 volts for silicon and 0.3 volts for germanium, the potential barriers opposition will be overcome and current will start to flow.

When a diode is connected in a Reverse Bias condition, a positive voltage is applied to the N-type material and a negative voltage is applied to the P-type material. The net result is that the depletion layer grows wider due to a lack of electrons and holes and presents a high impedance path, almost an insulator. The result is that a high potential barrier is created thus preventing current from flowing through the semiconductor material.

PROCEDURE :-

(1) Connections are made as shown in circuit diagram (i)
(2) The D C power supply is switched on keeping the voltage at zero.
(3) The voltage is increased in steps of 0.1 volt and at each step the readings of Ammeter and Voltmeter (Multi-meter) are noted.
(4) Connections are made as shown in circuit diagram (ii)
(5) The voltage is increased in steps of 1 volt and at each step the readings of ammeter and voltmeter are noted.
(6) Decrease the voltage, switch off the power supply.



Scale : X axis
1 cm=0.1V
Scale : Y axis

Forward Resistance = $R_f = \frac{BC}{AC}\ \Omega$ Reverse Resistance $= \frac{FE}{ED}\ \Omega$

TABULAR COLUMN :-

Forward Bias

I_{mA}	V volt

Reverse Bias

$I_{\mu A}$	V volt

RESULT :-

Forward Resistance of BY 127 = ________Ω Reverse Resistance of BY 127 = _________ Ω
Forward Reactance of OA 79 = __________ Ω Reverse Resistance of OA 79 = __________ Ω

(Note :- Before connecting the diode in the circuit, check the Anode and Cathode terminals using Multi-meter)

Experiment No.10

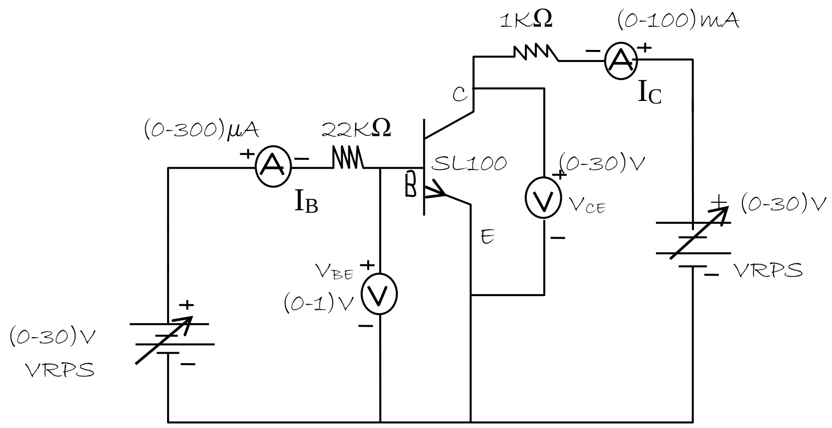
TRANSISTOR CHARACTERISTICS
STATIC CHARACTERISTICS OF A TRANSISTOR

AIM :- To determine the static characteristics of a Transistor in common emitter configuration.

APPARATUS REQUIRED :

Sl.No.	Instruments	Range	Quantity
1.	VRPS		02
2.	Resistors	100kΩ, 1kΩ	01
3.	Transistor	100Ω	01
4.	Ammeter	(0-100)mA, (0-500) µA	01
5.	Multi-meter	----	01
6.	Bread Board	----	01

CIRCUIT DIAGRAM :-



THEORY:

Transistors are three terminal active devices made from different semiconductor materials that can act as either an insulator or a conductor by the application of a small signal voltage. The transistor's ability to change between these two states enables it to have two basic functions: "switching" (digital electronics) or "amplification" (analogue electronics). Then bipolar transistors have the ability to operate within three different regions: (a) Active Region – the transistor operates as an amplifier (b) Saturation – the transistor is "Fully-ON" operating as a switch (c) Cut-off – the transistor is "Fully-OFF" operating as a switch.

In the Common Emitter configuration, the input signal is applied between the base and the emitter, while the output is taken from between the collector and the emitter as shown. This type of configuration is the most commonly used circuit for transistor based amplifiers

The common emitter amplifier configuration produces the highest current and power gain of all the three bipolar transistor configurations.

Input characteristics : The output voltage V_{CE} is kept constant and P.D between the base and emitter V_{BE} is gradually increased. The base current I_B is measured. The curves obtained by plotting base current on the y axis and V_{BE} on the x-axis at different values of V_{CE} are called input characteristics of the transistor. The reciprocal of the slope of the curve in the linear region gives input resistance Ri. For CE mode is very small.

Output Characteristics : The Base current I_B is kept constant and the output Voltage between the collector and emitter V_{CE} is gradually increased. The output current I_C is measured. The curves obtained by plotting collector current I_C on y-axis and V_{CE} on x-axis at different values of I_B are called output characteristics of the transistor.

PROCEDURE :-

INPUT CHARACTERISTICS :-

(1) Connections are made as shown by circuit diagram.
(2) The D C regulated power supply voltages are set to zero, they are switched ON.
(3) The collector voltage V_{CE} is set to some suitable value (Ex.5, 10,15V)
(4) The base voltage V_{BE} is increased in steps and at each step the base current and base to emitter voltage is tabulated for each fixed value of V_{CE}.
(5) Reduce the voltage V_{BE} tp zero.

OUTPUT CHARACTERISTICS :-

(1) The base current I_B is set at some suitable value by adjusting V_{BE} (I_B = 50,75 μA)
(2) The collector voltage V_{CE} is increased in steps and at each step the collector current and collector to emitter voltage are tabulated.
(3) Step 2 is repeated for some other value of the base current.
(4) V_{CE} and V_{BE} are reduce to zero, than DC power supply are switched off.

INPUT CHARACTERISTICS :-

V_{CE1} = __________ volts

V_{BE}	
I_B μA	

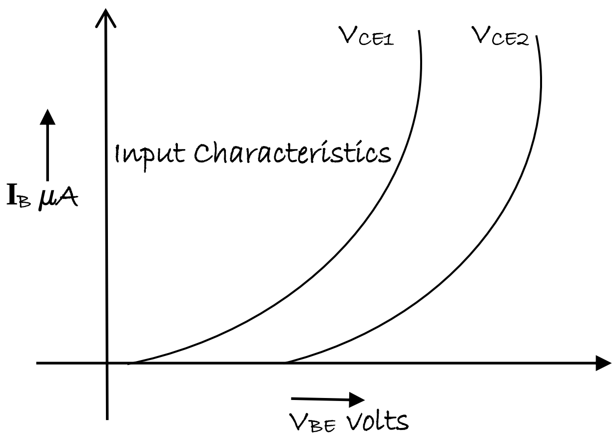
OUTPUT CHARACTERISTICS :-

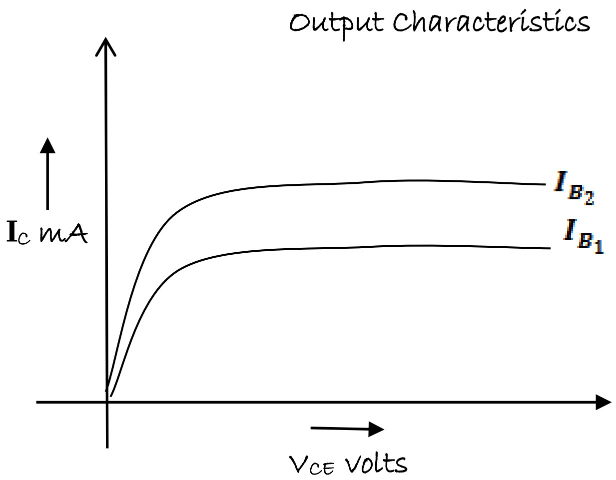
I_{B1} = __________ μA

V_{CE}	
I_C mA	

I_{B2} = __________ μA

V_{CE}		
I_C mA		





Experiment No.11

MEASUREMENT OF RESISTANCE

AIM :-

APPARATUS REQUIRED :

Sl.No.	Instruments	Range	Quantity
1.			
2.			
3.			
4.			
5.			
6.			

CIRCUIT DIAGRAM :-

THEORY: