EXPERIMENT NO : 1

TITLE: CHARACTERISTICS OF FLUORESCENT LAMPS.

OBJECTIVE: To study the starting method, minimum striking voltage and the effect of varying Voltage or current of a fluorescent lamp using A.C. supply.

APPARATUS:

Sl No	Apparatus Name	Apparatus Type	Range
1	Fluorescent Lamp		
2	Choke		
3	Starter		
4	Ammeter		
5	Voltmeter		
6	Wattmeter		
7	Variac		

THEORY:

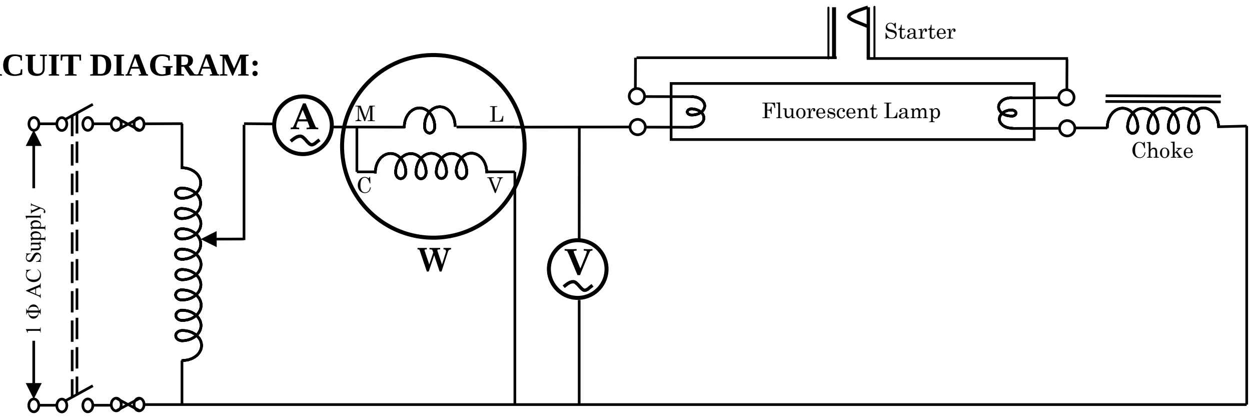
A fluorescent lamp is a low pressure mercury discharge lamp with internal surface coated with suitable fluorescent material. This lamp consists of a glass tube provided at both ends with caps having two pins and oxide coated tungsten filament. Tube contains argon and krypton gas to facilitate starting with small quantity mercury under low pressure. Fluorescent material, when subjected to electro-magnetic radiation of particular wavelength produced by the discharge through mercury vapors, gets excited and in turn gives out radiations at some other wavelength which fall under visible spectrum. Thus the secondary radiations from fluorescent powder increase the efficiency of the lamp. Tube lights in India are generally made either 61cm long 20 W rating or 122 cm long 40 Watt rating. In order to make a tube light self-starting, a starter and a chock are connected in the circuit.

When switch is on, full supply voltage from the variac appears across the starter electrodes P and Q which are enclosed in a glass bulb filled with argon gas. This voltage causes discharge in the argon gas with consequent heating of the electrodes. Due to this heating, the electrode V which is made of bimetallic strip, bends and cross contact of the starter. At this stage the choke, the filament M_1 and M_2 of the tube T and the starter become connected in series across the supply. A current flows through M_1 and M_2 and heats them. Meanwhile the argon discharge in the starter tube disappears and after a cooling time, the electrodes P and Q cause a sudden break in the circuit. This cause a high value of induced *emf* in the choke. The induced *emf* in the choke is applied across the tube light electrodes M_1 and M_2 and is responsible for initiating a gaseous discharge because initial heating has already created good number of free electrons in the vicinity of electrodes. Thus the tube light starts giving light output.

Power Factor (P.F.) of the lamp is somewhat low is about 0.5 lagging due to the inclusion of the choke. A condenser, if connected across the supply may improve the P.F. to about 0.95 lagging. The light output is a function of its supply voltage. At reduced supply voltage, the lamp may click a start but may fail to hold because of non-availability of reduced holding voltage across the tube. Higher normal voltage reduces the useful life of the tube light to very great extent.

If applied voltage of a fluorescent lamp is V, line current is I and input power is $P = VI\cos\Phi$ where COS Φ =(P/VI) = power factor of fluorescent lamp.

CIRCUIT DIAGRAM:



PROCEDURE:

1) Connect the circuit as shown in Fig.
2) Keep the variac in minimum or zero position.
3) Switch ON the ac supply and increase gradually till the lamp strikes.
4) Note down the reading of striking voltage.
5) Increase the applied voltage to the rated value step by step and note down the applied voltage, line current and power input to the lamp.
6) Now decrease applied voltage step by step till lamp extinguishes and note down applied voltage, line current and power input to lamp in each step. Note down the extinguishing voltage.
7) Switch OFF the power supply and disconnect the circuit from the supply.

OBSERVATION TABLE:

Sl No	Applied Voltage Increasing				Sl No	Applied Voltage Decreasing			
	Striking Voltage (volt)					Extinguishing Voltage (volt)			
	Applied Voltage (volt)	Line Current (mA)	Power Input (watt)	Power Factor		Applied Voltage (volt)	Line Current (mA)	Power Input (watt)	Power Factor
1					**1**				
2					**2**				
3					**3**				
4					**4**				
5					**5**				
6					**6**				
7					**7**				
8					**8**				
9					**9**				
10					**10**				

CALCULATION:

RESULT: Draw graph of Input Power vs. Applied Voltage and Applied Voltage vs. Line Current.

DISCUSSION:

QUESTION:

1. What is the function of starter? What is the function of choke?
2. Can we use fluorescent lamp in DC?

EXPERIMENT NO : 2

TILLE: CHARACTERISTICS OF TUNGSTEN FILAMENT LAMPS

OBJECTIVE : To study and draw the following characteristics of Tungsten Filament Lamp

I. Voltage vs. Current
II. Resistance vs. Voltage
III. Voltage vs. Power

APPARATUS:

Sl No	Apparatus Name	Apparatus Type	Range
1	Tungsten Lamp		
2	Ammeter		
3	Voltmeter		
4	Wattmeter		
5	Variac		

THEORY:

There are two types of lamps which are in common use, one is filament lamp and the other is gaseous discharge lamp. The filament lamps are incandescent lamps, e.g. carbon, tungsten etc. The filament of these lamps, when heated due to electric current, emits radiations in visible spectrum. The filament of incandescent lamp is mostly made of tungsten wire whose melting point is 3400^{0}C. At normal working voltage, the filament material gets heated to a very high temperature and emits white light. The filament is made in the form of a coiled-coil to contain a longer length of the filament in a shorter space and is enclosed in an evacuated glass bulb to minimize oxidation of filament material at such a high operating temperature. Usually the lamps above 15w or 25w are filled with an inert gas, e.g. argon or nitrogen, to enable the filament to operate at higher temperatures and achieve higher lumens/watt efficiency (in the range of 12-13watt).

The resistance of filament changes considerably when switched on. The initial resistance of the filament in cold condition can be measured by multi-meter or by ammeter-voltmeter method. The filament resistance at normal operating temperature is difficult to measure directly and is therefore, calculated by using the following relation:

$$R = W/I^2 \ \Omega$$

Where, R = Resistance in ohm when normal voltage is applied across the lamp

I = Current taken by the lamp in ampere.

W= Power to the lamp in Watt

Basic reason of getting all these conductors heated is their resistance. Resistance is the physical property of a substance by virtue of which it opposes the flow of current through it. Conductors offer lower resistance than insulators.

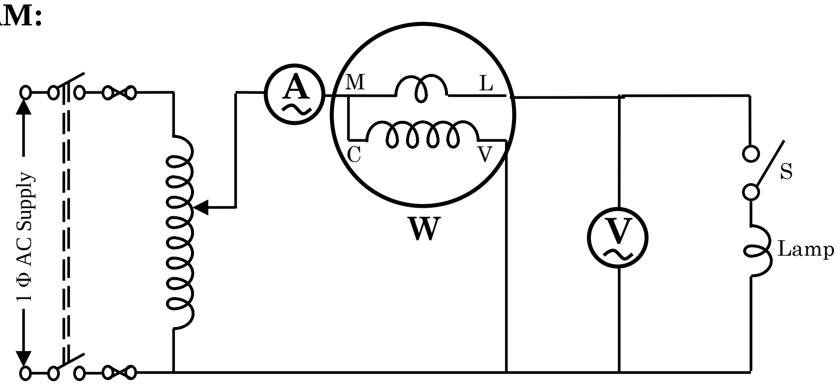
Experiments have shown that the resistivity is affected by the conductor’s temperature. The resistivity and, hence, the resistance of most of the conducting materials increases with increase in temperature. The resistance changes with temperature according to the relation:

$$R_T = R_0\left[1+\alpha\left(T-T_0\right)\right]$$

Where R_T and R_0 are the value of resistances of the conductor at T and T_0 respectively and α is a constant called temperature coefficient of resistance. T_0 is often taken to be either room temperature or 0° C.

The value of α is very small for pure metal, so their resistance increase with increasing temperature. The temperature co-efficient of Tungsten Filament and Carbon Filament lamp are 0.0045 and – 0.0005 respectively.

CIRCUIT DIAGRAM:



PROCEDURE:

1) Connect the circuit diagram as shown in Fig.
2) Keep the variac in minimum or zero position.
3) Switch ON the power supply and increase the applied voltage gradually in step by step.
4) Note down the applied voltage, load current and input power for every step.
5) Switch OFF power supply and disconnect circuit. Calculate the resistance at every step.

OBSERVATION TABLE:

Sl. No	Applied Voltage (volt)	Load Current (amp)	Input Power (watt)	Resistance (Ω)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

CALCULATION:

RESULT: Draw the graph of Voltage vs. Current, Resistance vs. Voltage and Voltage vs. Power.

DISCUSSION:

QUESTION:

1. What is the nature (i.e. positive or negative) of the slop of the voltage vs. Resistance characteristics of Tungsten Filament Lamp? Explain it briefly.

EXPERIMENT NO : 3

TITLE: VERIFICATION OF THEVENIN'S THEOREM.

OBJECTIVE : To verify the Thevenin's Theorem in the DC circuit.

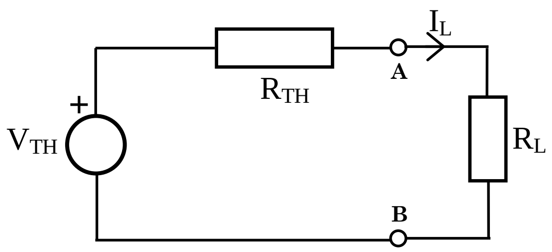
APPRATUS :

Sl No	Apparatus Name	Apparatus Type	Range
1	Trainer Kit		
2	Voltage Source		
3	Resistor 1, 2 & 3		
4	Ammeter		
5	Voltmeter		
6	Multimeter		

THEORY:

Thevenin's theorem as applied to DC circuit may be stated as:

Current fowling through a load resistance R_L *connected across any two terminal A and B of a linear, bilateral network is given* $\frac{V_{TH}}{R_{TH}+R_L}$*, where* V_{TH} *is the open circuit voltage or thevenin's equivalent voltage (i.e. voltage across terminal AB when* R_L *is removed) and* R_{TH} *is the by equivalent resistance of the network as viewed from the open circuited load terminals i.e. from terminal AB deactivating all independent source.*



Mathematically current through the load resistance R_L is given by the equation –

$$I_L = \frac{V_{TH}}{R_{TH}+R_L}$$

Where, I_L = Load Current

V_{TH} = Open circuit voltage across the terminals AB.

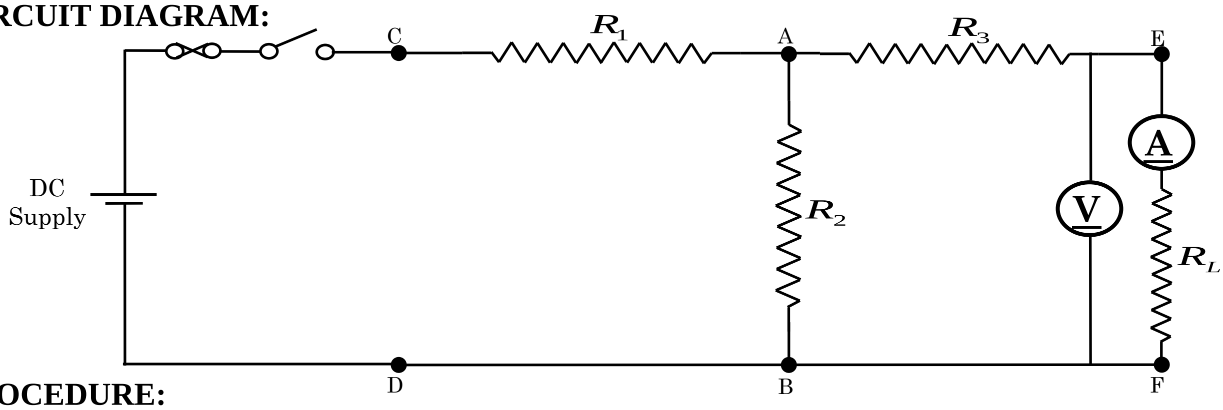
R_{TH} = Thevenin's Resistance

R_L = Load Resistance

The following are the limitation of this theorem

i. Thevenin's theorem cannot be applicable for non-linear network.
ii. This theorem cannot calculate the power consumed internally in the circuit or efficiency of the circuit.

CIRCUIT DIAGRAM:



PROCEDURE:

1) Connect the circuit diagram as shown in Fig.
2) Measure the value of R_1, R_2 and R_3.
3) Remove the R_L i.e. open the terminal EF.
4) Switch ON the power supply and note down the open circuit voltage ($V_{OC} = V_{TH}$).
5) Now remove the voltage source by replacing their internal resistance. If the internal resistance is assumed to be zero, then short the terminal C & D.
6) Measure the R_{TH} across by opening the terminal EF by multimeter or ammeter-voltmeter method.
7) Reconnect the power supply and note down the load current I_{Lo} with a load resistance of 25 Ω, 50 Ω and 100 Ω respectively and compare with calculated values of I_{Lc}. Also calculate the error for each load.
8) Switch OFF the power supply and disconnect the circuit.

OBSERVATION TABLE:

R_1 = Ω R_2 = Ω R_3 = Ω

Sl. No.	Thevenin's Voltage (volt)	Equivalent Resistance (Ω)	Load Resistance (Ω)	Load Current I_{Lo} (mA)
1				
2				
3				

CALCULATION TABLE:

Calculated Thevenin's Voltage = volt

Calculated Equivalent Resistance = Ω

Sl. No.	Load Resistance R_L (Ω)	Load Current		Error $\frac{I_{Lc} - I_{Lo}}{I_{Lc}} \times 100\%$
		Observed Value I_{Lo} (mA)	Calculated Value I_{Lc} (mA)	
1				
2				
3				

CALCULATION:

RESULT: Thus the Thevenin's theorem is verified.

DISCUSSION:

QUESTION:

1. Can we apply the Thevenin's Theorem to AC circuit?
2. Can this theorem be applied to network which contains non-linear resistance?

EXPERIMENT NO : 4

TITLE: VERIFICATION OF SUPERPOSITION THEOREM.

OBJECTIVE : To verify the Superposition Theorem in the DC circuit.

APPRATUS :

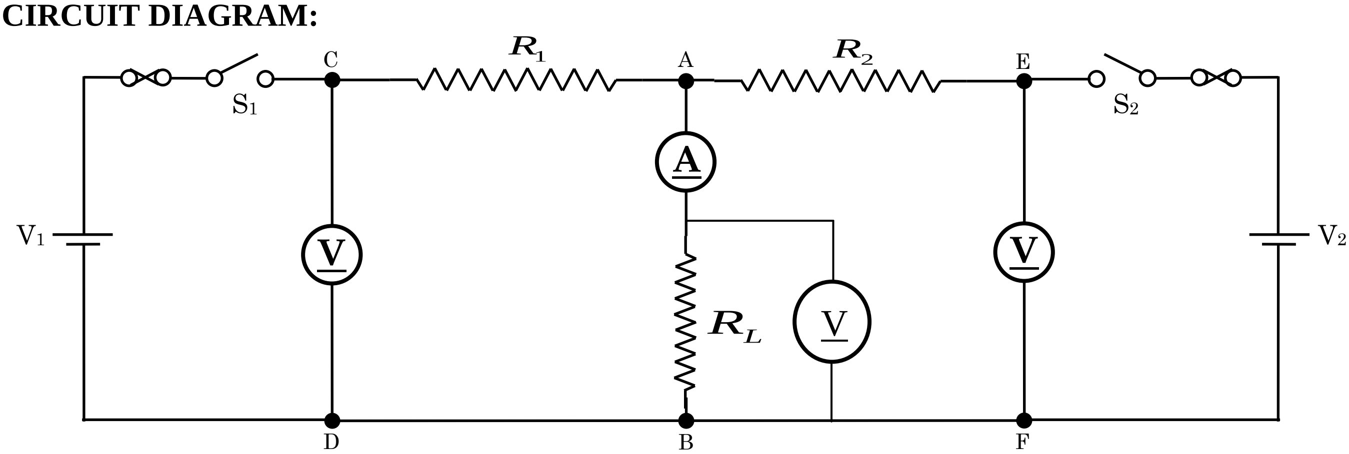
Sl No	Apparatus Name	Apparatus Type	Range
1	Trainer Kit		
2	Voltage Source		
3	Resistor 1, 2 & 3		
4	Ammeter		
5	Voltmeter 1		
6	Voltmeter 2		
7	Multimeter		

THEORY:

Superposition Theorem as applied for DC circuit may be stated as:

In any linear active bilateral network containing several sources, the current through or voltage across any branch in the network equals the algebraic sum of the currents or voltages of each individual source considered separately with all other sources made inoperative, i.e. replaced by resistance equal to their internal resistance.

CIRCUIT DIAGRAM:



PROCEDURE:

1) Connect the circuit diagram as shown in Fig.
2) Measure the value of R_1, R_2 and R_L.
3) Switch ON the power supply by closing switch S_1 and S_2.
4) Note down the total current (I_L) flowing through resistance R_L due to both the sources is measured.
5) Replace the source V_1 by its internal resistance. If internal resistance is zero it is shorted C and D. Switch ON the power supply by closing switch S_1. Note down the load current I_{L1} through the resistance R_L due to the source V_1.
6) Reconnect the source V_1 and replace the source V_2 by its internal resistance. If internal resistance is zero it is shorted E and F. Switch ON the power supply by closing switch S_2. Note down the load current I_{L2} through the resistance R_L due to the source V_2.
7) Switch OFF the power supply and disconnect the circuit.
8) Compare the total load current I_L with the sum of I_{L1} and I_{L2}.

OBSERVATION TABLE:

V_1 = volt V_2 = volt

R_1 = Ω R_2 = Ω R_L = Ω

Condition	**Measured Value (Me)**	
	Load Voltage (Volt)	**Load Current (mA)**
Both V_1 and V_2 present	V_L	I_L
V_1 present and V_2 replace by internal resistance	V_{L1}	I_{L1}
V_2 present and V_1 replace by internal resistance	V_{L2}	I_{L2}
Algebraic Sum	$V_L=V_{L1}+V_{L2}$	$(I_L=I_{L1}+I_{L2})$

CALCULATION TABLE:

Condition	**Load Voltage (volt)**		**Error** $\frac{Th - Me}{Th} \times 100\%$
	Measured Value	**Calculated Value**	
V_1 present and V_2 replace by internal resistance	V_{L1m}	V_{L1c}	
V_2 present and V_1 replace by internal resistance	V_{L2m}	V_{L2c}	
Both V_1 and V_2 present (Algebraic Sum)	$V_{Lm}=V_L$	$(V_{Lc}=V_{L1c}+V_{L2c})$	

Condition	**Load Current (mA)**		**Error** $\frac{Th - Me}{Th} \times 100\%$
	Measured Value	**Calculated Value**	
V_1 present and V_2 replace by internal resistance	I_{L1m}	I_{L1c}	
V_2 present and V_1 replace by internal resistance	I_{L2m}	I_{L2c}	
Both V_1 and V_2 present (Algebraic Sum)	$I_{Lm}=I_L$	$(I_{Lc}=I_{L1c}+I_{L2c})$	

CALCULATION:

RESULT: Thus the Superposition theorem is verified.

DISCUSSION:

QUESTION:

1. Can we apply the Superposition Theorem to AC circuit?
2. Does non-linear system obey the superposition theorem? Explain it.

EXPERIMENT NO : 5

TITLE: STUDY THE RLC SERIES CIRCUIT.

OBJECTIVE : To study the RLC series circuit and draw the following characteristics

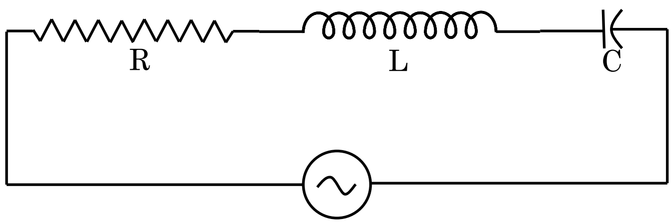
I. Frequency vs. Resistance
II. Frequency vs. Impedance
III. Frequency vs. Inductive reactance
IV. Frequency vs. Capacitive reactance
V. Frequency vs. Current

APPRATUS :

Sl No	Apparatus Name	Apparatus Type	Range
1	Resistor		
2	Inductor		
3	Capacitor		
4	Voltmeter		
5	Audio Frequency Generator		

THEORY:

Consider an AC circuit containing resistance R, inductor L and a capacitor C connected in series as shown in figure below



The Impedance $Z = \sqrt{R^2 + X^2} = \sqrt{R^2 + (X_L - X_C)^2}$

Where $X_L = 2\pi fL$ and $X_C = \frac{1}{2\pi fC}$.

At resonance $X_L = X_C$ i.e. $X_L - X_C = 0$. Therefore impedance of the circuit is R i.e. $Z = R$. So, current flowing through the circuit is maximum, given by $I = \frac{V}{R}$. In that condition voltage drop across the inductor and voltage drop across the capacitor is same and the power factor is unity. When these conditions are exists, the circuit is said to be in resonance. The frequency at which this occurs is called Resonance frequency, f_r.

At resonance $X_L = X_C$

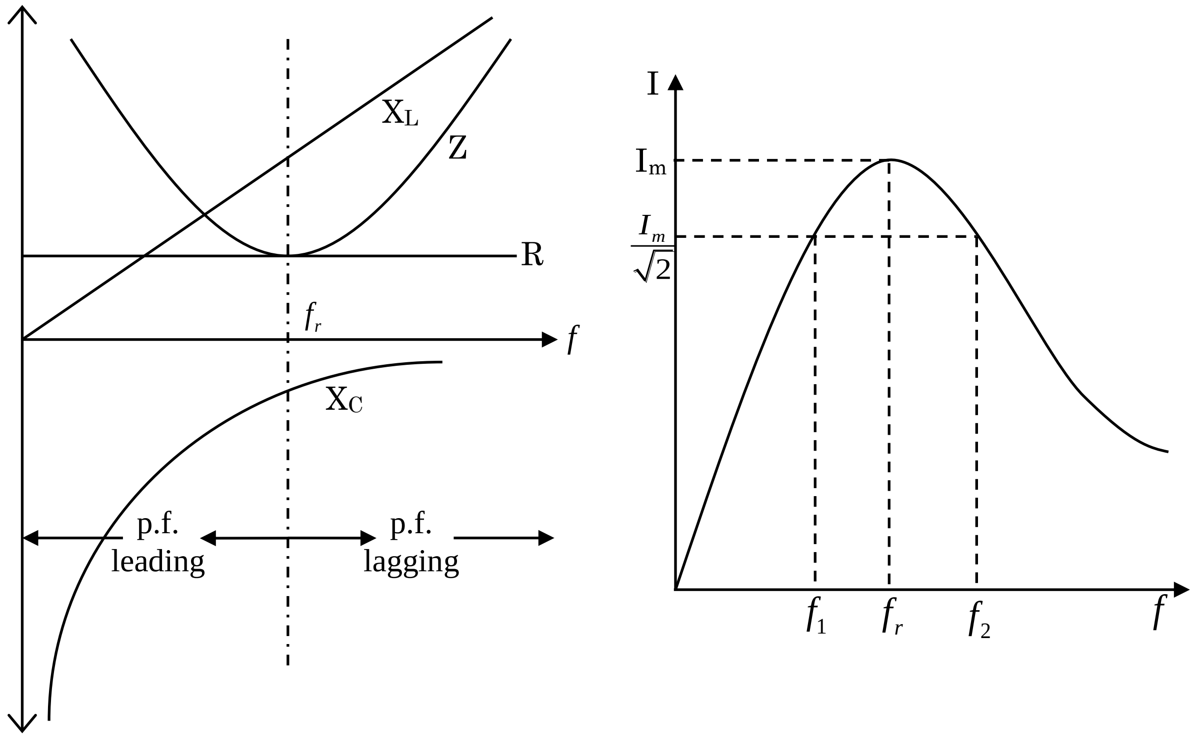
So $\omega_r L = \frac{1}{\omega_r C}$

$$\omega_r^2 = \frac{1}{LC}$$

$$\omega_r = \frac{1}{\sqrt{LC}}$$

Therefore resonance frequency, $f_r = \frac{1}{2\pi\sqrt{LC}}$. Hence, the value of resonance frequency depends on the parameter of the two energy storing elements.

The variation of resistance, inductive reactance, capacitive reactance and impedance with respect to frequency are plotted in Fig. 1.



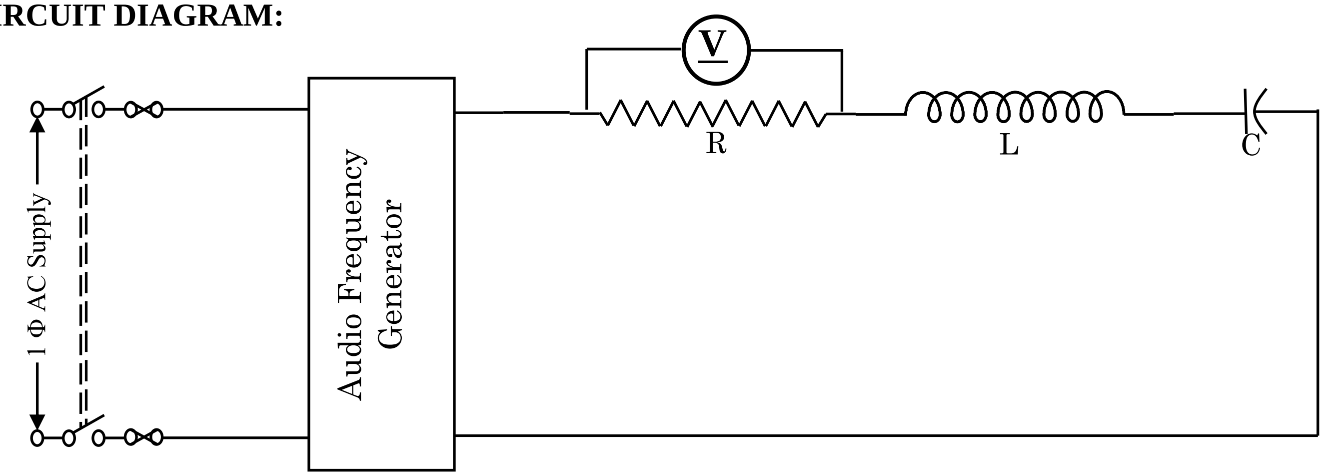
The variation of current I with respect to frequency is also shown in above fig. From the above fig. bandwidth frequency = $f_2 - f_1$. So

$$\text{Q Factor} = \frac{f_r}{f_2 - f_1}$$

The Q Factor is also calculated by the following equation

$$\text{Q Factor} = \frac{\omega_r L}{R} = \frac{2\pi f_r L}{R}$$

CIRCUIT DIAGRAM:



PROCEDURE:

1) Connect the circuit diagram as shown in Fig.
2) Switch ON the power supply.
3) Vary the frequency step by step in small steps by adjust frequency variation knob.
4) Note down the voltmeter reading which indicate voltage across the resistance.
5) Switch OFF the power supply and disconnect the circuit.

OBSERVATION TABLE:

Sl. No	Frequency f (Hz)	Resistance R (Ω)	Inductance L (mH)	Inductive Reactance X_L (Ω)	Capacitance C (μF)	Capacitive Reactance X_C (Ω)	Impedance Z (Ω)	Voltage across R V_R (volt)	Current $I = V_R/R$ (amp)
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

CALCULATION:

RESULT: Calculate resonance frequency, bandwidth and Q – factor. Also draw the following characteristics

I. Frequency vs. Resistance
II. Frequency vs. Impedance
III. Frequency vs. Inductive reactance
IV. Frequency vs. Capacitive reactance
V. Frequency vs. Current

DISCUSSION :

QUESTION:

1. What is resonance? State the resonance condition for series RLC circuit.
2. Define Band Width and Q – factor.
3. Draw the phasor diagram for series RLC circuit.

EXPERIMENT NO : 6

TITLE: SPEED CONTROL OF DC SHUNT MOTOR

OBJECTIVE : To study the speed control of a DC shunt motor using

A. Field current control
B. Armature voltage control

APPARATUS:

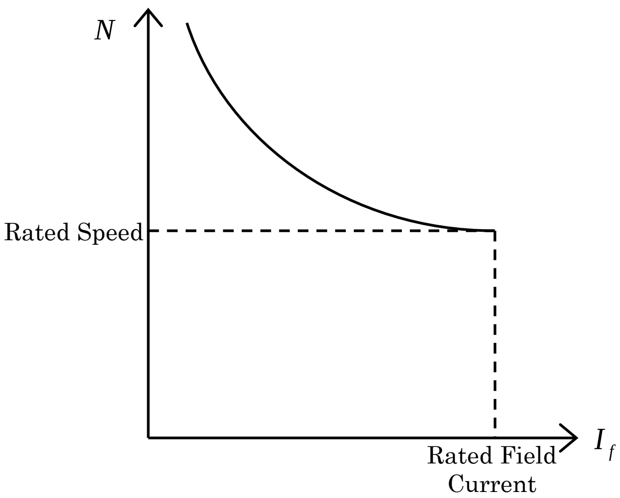
Sl No	Apparatus Name	Apparatus Type	Range/ Specification
1	DC Motor		
2	Ammeter		
3	Voltmeter		
4	Rheostat		
5	Tachometer		

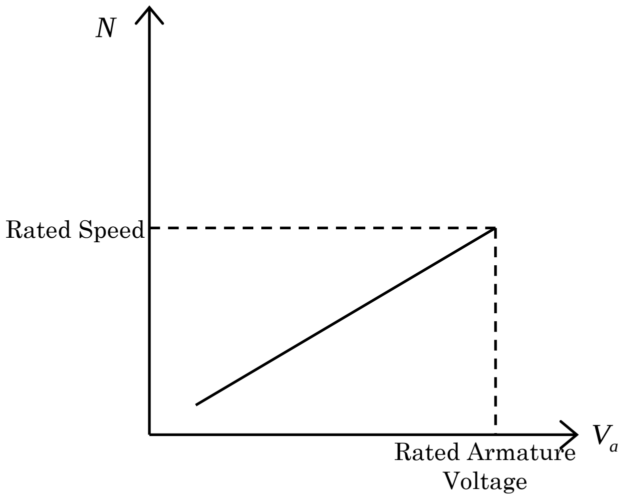
THEORY: The equation governing the speed of a dc shunt motor is

$$N \propto \frac{V - I_a R_a}{\Phi}$$

Where N = speed of the motor
V = applied voltage
I_a = armature current
R_a = armature resistance
Φ = field flux

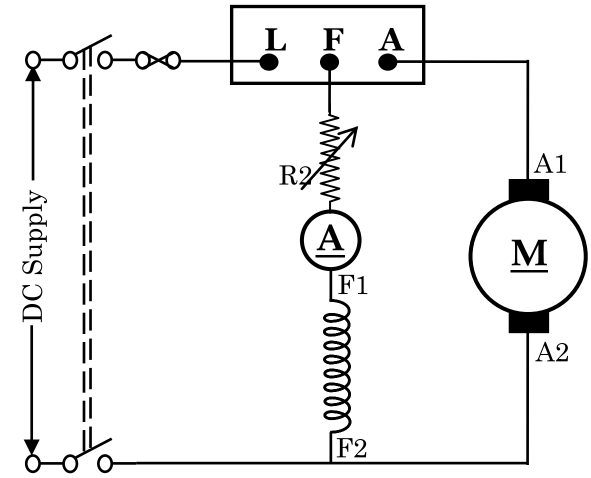
In the above equation R_a is constant. So we can control the speed of motor in two ways. Firstly by changing the field flux Φ and secondly by changing the armature voltage $(V - I_a R_a)$. In the both case we vary the speed of motor by introducing a rheostat in the field circuit and armature circuit respectively.



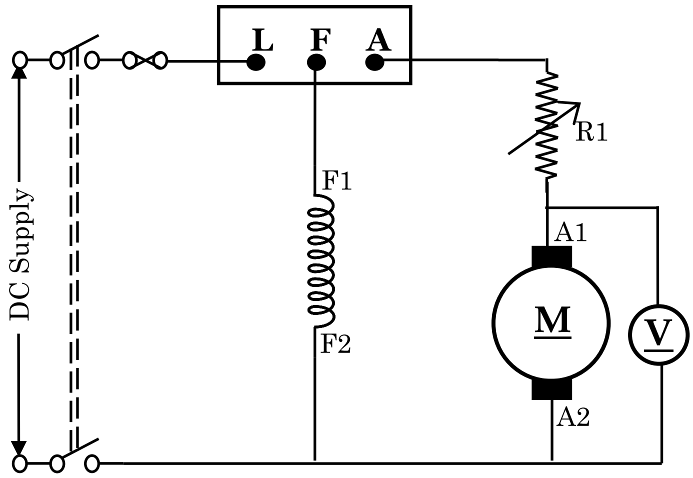


CIRCUIT DIAGRAM:

1. FIELD CONTROL METHOD



2. ARMATURE CONTROL METHOD



PROCEDURE:

1) Connect the circuit as shown in Fig.
2) Keep the armature rheostat to its maximum value and the field rheostat to its minimum value.
3) Switch ON the DC supply and start the motor by 3 point starter.
4) Gradually decrease the resistance R_1 to zero keeping resistance R_2 constant.
5) Note down the voltmeter reading (V_a) and speed N in each step.
6) Gradually increase the resistance R_2 to zero keeping resistance R_1 constant.
7) Note down the ammeter reading (I_f) and speed N in each step.
8) Switch OFF the power supply.
9) Draw the graph N vs. I_f and N vs. V_a

OBSERVATION TABLE:

Sl No	Field control Method		Armature Control Method	
	Field Current I_f (amp)	Speed N (rpm)	Armature Voltage V_a (volt)	Speed N (rpm)
1				
2				
3				
4				
5				

RESULT: The expected graph for speed control of dc shunt motor by armature control method and field control method is shown in below.

DISCUSSION:

QUESTION:

1. Why we use the starter for starting the DC Shunt motor?

EXPERIMENT NO : 7

TITLE: STUDY OF THE EQUIVALENT CIRCUIT OF A SINGLE-PHASE TRANSFORMER.

OBJECTIVE : To determine the parameter of the equivalent circuit of a single phase transformer

APPRATUS :

Sl No	Apparatus Name	Apparatus Type	Range/Specification
1	Transformer		
2	Ammeter		
3	Voltmeter		
4	Wattmeter		
5	Variac		

THEORY:

1. **OPEN CIRCUIT (OC) OR NO-LOAD TEST**

The purpose of this test is to determine the shunt branches parameter of the equivalent circuit of the transformer. This test is performed in LV side which is connected to rated supply voltage at rated frequency and HV side is kept open as shown in fig. The exciting current being about 2 to 6 % of full load current and the ohmic loss in the primary i.e. LV side varies from 0.04 % to 0.36 % of full load ohmic loss. In view of this ohmic loss during open circuit test is negligible in comparison with the core loss. Hence the wattmeter reading can taken as equal to transformer core loss.

Let consider V_o = Applied voltage on low voltage side

I_o = Exciting current or No-load current

P_o = Core loss

Then $P_o = V_o I_o \cos\Phi_o$

Therefore no load power factor $\cos\Phi_o = \frac{P_o}{V_o I_o}$

The energy component of no load current $I_e = I_o \cos\Phi_o$

The magnetizing component of no load current $I_m = I_o \sin\Phi_o$

Therefore core loss resistance $R_o = \frac{V_o}{I_e}$

And magnetizing reactance $X_o = \frac{V_o}{I_m}$

2. **SHORT CIRCUIT (SC) TEST**

This test is performed to determine the series parameter of equivalent circuit of transformer as well as to obtain the full load copper loss of a single phase transformer. The LV side of the transformer is short circuited and the instruments are placed in HV side. The applied voltage is varied by variac to supply the rated current on HV side. As the primary mmf is almost equal to the secondary mmf in transformer, therefore rated current in high voltage winding cause the flow of rated current in low voltage winding. The wattmeter, in short circuit test, records the core loss and ohmic loss in both the winding. Since the core loss has been also negligible in comparison with rated voltage core loss, wattmeter reading can taken as equal to transformer ohmic loss in both winding.

Let consider V_{sc} = Applied voltage on high voltage side

I_{sc} = Short circuit current on high voltage side

P_{sc} = Total ohmic loss

Then the total equivalent resistance referred to high voltage side $R_{eq} = \frac{P_{sc}}{I_{sc}^2}$

The total equivalent impedance referred to high voltage side $Z_{eq} = \frac{V_{sc}}{I_{sc}}$

Therefore the total equivalent reactance referred to high voltage side $X_{eq} = \sqrt{Z_{eq}^2 - R_{eq}^2}$

CIRCUIT DIAGRAM:

1. **OPEN CIRCUIT TEST**

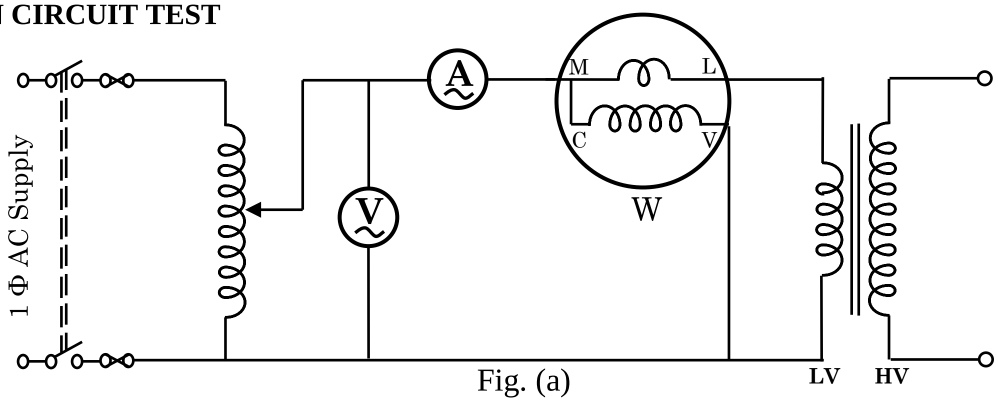


Fig. (a)

2. **SHORT CIRCUIT TEST**

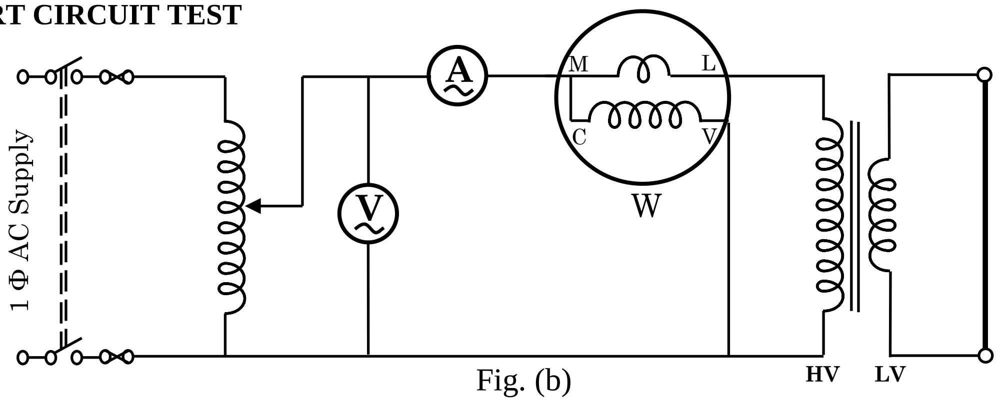


Fig. (b)

PROCEDURE :

1) Connect the circuit as shown in Fig (a)
2) Set the variac at zero output voltage.
3) Switch ON the supply and by varying the applied voltage in step from zero to rated voltage of low voltage (LV) side.
4) Note down the ammeter, voltmeter and wattmeter reading.
5) Disconnect the circuit from supply and again connect the circuit as shown in Fig (b)
6) Set the variac at zero output voltage.
7) Switch ON the supply and increase the input voltage of transformer starting from zero in varying small step till ammeter indicates the full load current of high voltage (HV) side.
8) Note down the ammeter, voltmeter and wattmeter reading.
9) Disconnect the circuit from supply.
10) Calculate the different parameter of transformer from the record data.
11) Draw the equivalent circuit of single phase transformer.

OBSERVATION TABLE:

Open Circuit Test			Short Circuit Test		
Voltage V_o (volt)	Current I_o (Amp)	Power Input P_o (watt)	Voltage V_{sc} (volt)	Current I_{sc} (Amp)	Power Input P_{sc} (watt)

CALCULATION:

RESULT: Core loss resistance, R_o = ohm
Magnetizing reactance, X_o = ohm
Total equivalent resistance referred to high voltage side, R_{eq} = ohm
Total equivalent reactance referred to high voltage side, X_{eq} = ohm

DISCUSSION:

QUESTION:

1. Draw the equivalent circuit diagram of single phase transformer.

EXPERIMENT NO : 8

TITLE: VERIFICATION OF NORTON'S THEOREM.

OBJECTIVE : To verify the Norton's Theorem in the DC circuit.

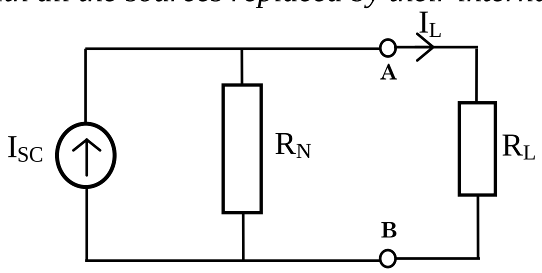
APPRATUS:

Sl No	Apparatus Name	Apparatus Type	Range
1	Trainer Kit		
2	Voltage Source		
3	Resistor 1,2,3 & 4		
4	Ammeter		
5	Multimeter		

THEORY:

Norton's Theorem as applied for DC circuit may be stated as:

Any two terminal linear, active, bilateral networks containing voltage source and resistance when viewed from its output terminals is equivalent to a constant current source and a parallel connected equivalent resistance. The constant current source (Norton's equivalent current source) is of magnitude of the short circuit current at the terminals. The internal resistance is equivalent resistance of the network looking back into the terminal with all the sources replaced by their internal resistance.



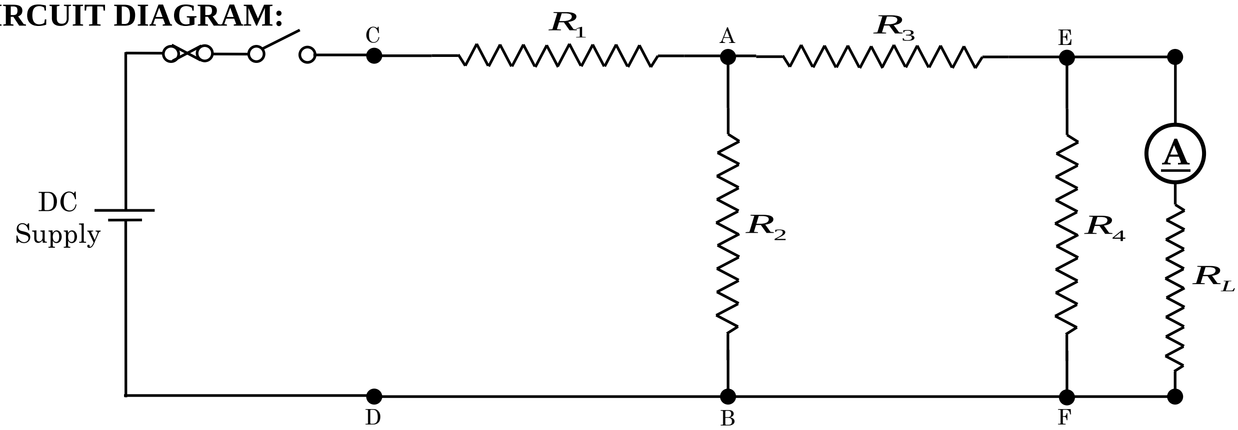
Mathematically, current through the load resistance R_L is given by the equation

$$I_L = I_{SC}\frac{R_N}{R_N + R_L}$$

Where, I_L = Load Current R_N = Norton's Resistance

I_{SC} = Short circuit current across the terminals. R_L = Load Resistance

CIRCUIT DIAGRAM:



PROCEDURE:

1) Connect the circuit diagram as shown in Fig.
2) Measure the value of R_1, R_2, R_3 and R_4.
3) Remove the R_L and short the line.
4) Switch ON the power supply and note down ammeter reading as short circuit current ($I_{SC} = I_N$).
5) Now remove the voltage source by replacing their internal resistance. If the internal resistance is assumed to be zero, then short the terminal C & D.
6) Measure the R_N across by opening the terminal EF by multimeter or ammeter-voltmeter method.
7) Note down the load current I_{Lo} with a load resistance of 25 Ω, 50 Ω and 100 Ω respectively and compare with calculated values of I_{Lc}. Also calculate the error for each load.
8) Switch OFF the power supply and disconnect the circuit.

OBSERVATION TABLE:

R_1 = Ω R_2 = Ω R_3 = Ω R_4 = Ω

Sl. No.	Norton's Current (mA)	Equivalent Resistance (Ω)	Load Resistance (Ω)	Load Current I_{Lo} (mA)
1				
2				
3				

CALCULATION TABLE:

Calculated Norton's Current = mA
Calculated Equivalent Resistance = Ω

Sl. No.	Load Resistance R_L (Ω)	Load Current		Error
		Observed Value I_{Lo} (mA)	Calculated Value I_{Lc} (mA)	$\frac{I_{Lc} - I_{Lo}}{I_{Lc}} \times 100\%$
1				
2				
3				

CALCULATION:

RESULT: Thus the Norton's theorem is verified.

DISCUSSION:

QUESTION:

1. Can we apply the Norton's Theorem to AC circuit?
2. Can this theorem be applied to network which contains non-linear resistance?

EXPERIMENT NO : 9

TILLE: CALIBRATION OF MI TYPE AMMETER AND VOLTMETER

OBJECTIVE : To calibrate MI type ammeter and voltmeter with a standard(PMMC) ammeter and voltmeter.

APPARATUS:

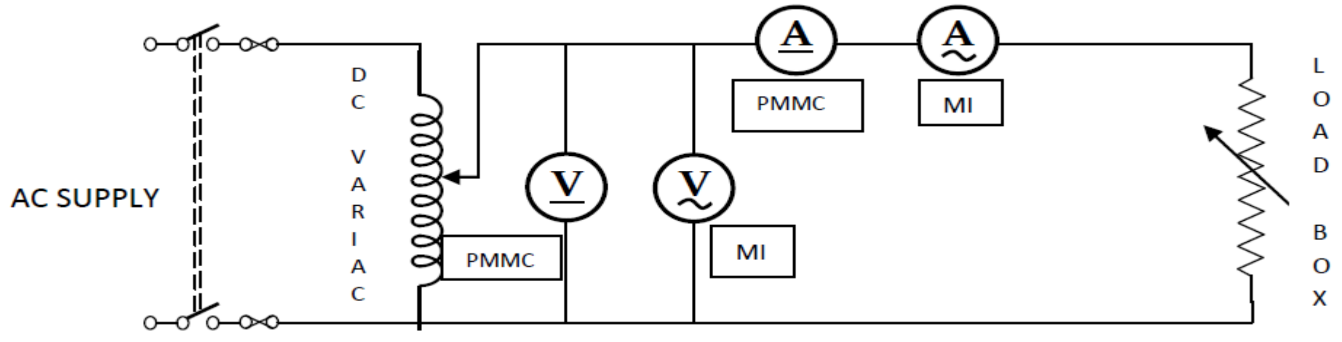
Sl No	Apparatus Name	Apparatus Type	Quantity	Range
1	Variac			
2	MI Ammeter			
3	PMMC Ammeter			
4	MI Voltmeter			
5	PMMC Voltmeter			
6	Load Box			

THEORY:

The calibration of all instruments is important since it affords the opportunity to check the instrument against a known standard and subsequently to find errors and accuracy. Calibration procedures involve a comparison of the particular instrument with either (1) a primary standard, (2) a secondary standard with a higher accuracy than the instrument to be calibrated, or (3) an instrument of known accuracy. So all working instrument must be calibrated against some reference instruments, which have higher accuracy.

Permanent-magnet moving coil type instrument can be used for direct current measurements only but moving iron instruments can be used for both AC and DC quantity measurement. Although, the moving iron instruments are responsive to DC, the hysteresis effect causes an appreciable error in measurement. But the permanent magnet moving coil instrument is the most accurate type for direct current measurement. So it is important to know the error in the reading of moving iron voltmeter and ammeter when the DC voltage or current is measured in any circuit.

CIRCUIT DIAGRAM:



PROCEDURE:

1) The circuit is connected as shown in the circuit diagram.
2) Any zero error of test meters can be adjusted now. If it is allowed to remain, it would give a definite offset to the error.
3) Switch on the supply.
4) Observe the Voltmeter (PMMC & MI) and Ammeter (PMMC & MI) readings.
5) By varying the load from Load-Box note down reading for different loads.
6) Calculate the errors caused by the moving iron voltmeter and ammeter with reference to permanent magnet moving coil voltmeter and ammeter.

OBSERVATION TABLE:

Sl. No	Standard Voltmeter (PMMC) reading (Vs)	Calibrated Voltmeter (MI) reading (Vc)	Standard Ammeter (PMMC) reading (Is)	Calibrated Ammeter (MI) reading (Ic)	Errors in%	
					Voltmeter	Ammeter
1						
2						
3						
4						
5						

CALCULATION: To calibrate, the reading of the test(MI) instruments are compared with a standard (PMMC) instrument. The difference is called error. The error may be positive or negative.

This error may be calculated as error= Indicated reading(MI reading)- Standard(PMMC) reading

The percentage error is calculated as,

%error= {(Indicated reading- Standard reading)/(Standard reading)}× 100

RESULT: Draw graph of Calibrated Voltmeter vs. Error in % of Voltmeter and Calibrated Ammeter vs. Error in % of Ammeter.

DISCUSSION:

QUESTION:

1. Why calibration of instrument is necessary?
2. If there is any other method to calibrate voltmeter and ammeter?