Jawaharlal Nehru Engineering College

Laboratory Manual

ELEMENTS OF ELECTRICAL ENGG.

For

First Year Students

Manual made by

Prof. M.S. Shinde

FOREWORD

It is my great pleasure to present this laboratory manual for first year engineering students for the subject of Elements of Electrical Engineering. Keeping in view the vast coverage required for visualization of concepts of basic electrical with simple language.

As a student, many of you may be wondering with some of the questions in your mind regarding the subject and exactly what has been tried is to answer through this manual.

Faculty members are also advised that covering these aspects in initial stage itself, will greatly relieved them in future as much of the load will be taken care by the enthusiasm energies of the students once they are conceptually clear.

H.O.D
B.T.Deshmukh

LABORATORY MANUAL CONTENTS

This manual is intended for the first year students of engineering branches in the subject of Elements of Electrical Engineering. This manual typically contains practical/Lab Sessions related electrical fundamentals covering various aspects related to the subject to enhance understanding.

Although, as per the syllabus, we have made the efforts to cover various aspects of electrical fundamentals subject covering will be complete in itself to make it meaningful, elaborative understandable concepts and conceptual visualization.

Students are advised to thoroughly go though this manual rather than only topics mentioned in the syllabus as practical aspects are the key to understanding and conceptual visualization of theoretical aspects covered in the books.

Good Luck for your Enjoyable Laboratory Sessions

Prof. M. S. Shinde

SUBJECT INDEX

1. DOs and DON'Ts in Laboratory:

1. Understand the equipment to be tested and apparatus to be used .

2. Select proper type (i.e. A. c. or D. C.) and range of meters.

3. Do not touch the live terminals.

4. Use suitable wires (type and size).

5. All the connection should be tight.

1. Do not leave loose wires (i.e. wires not connected).

2. Get the connection checked before switching 'ON' the supply.

3. Never exceed the permissible values of current, voltage, and / or speed of any machine, apparatus, wire, load, etc.

4. Switch ON or OFF the load gradually and not suddenly.

5. Strictly observe the instructions given by the teacher/Lab Instructor

Instruction for Laboratory Teachers::

1. Submission related to whatever lab work has been completed should be done during the next lab session. The immediate arrangements for printouts related to submission on the day of practical assignments.

2. Students should be taught for taking the observations /readings of different measuring instruments under the able observation of lab teacher.

3. The promptness of submission should be encouraged by way of marking and evaluation patterns that will benefit the sincere students.

2. Lab Exercises:

[Purpose these exercises is introduce the students to fundamentals of Electrical Engg.]

Exercise No1: (2 Hours) – 1 Practical

House Wiring.

AIM: To control two lamps by two separate switches.

APPARATUS:

1. Kit Kat fuse: 1Nos. 5 Amps.
2. Single pole switch: 2 Nos. , 5 Amps
3. Lamp holders: 2 Nos. , 5 Amps
4. Lamps: 2 Nos.
5. Battens, Nails, Clips, CTS wire, Fuse wire.
6. Round wooden block: 04 Nos.
7. Square wooden block: 01 Nos.

PROCEDURE:

1. Fix the battens at suitable distance as per the circuit diagram.
2. Cut the wire of suitable sizes. Fix the clips with nails on the battens & put the wire as per circuit diagram, The wire should not cross each other on the batten.
3. Fix the wooden blocks as per correct position & complete the wiring As per circuit diagram.
4. Put fuse wire in Kitkat fuse.
5. Test the complete wiring as per testing procedure.

OBSERVATION:-

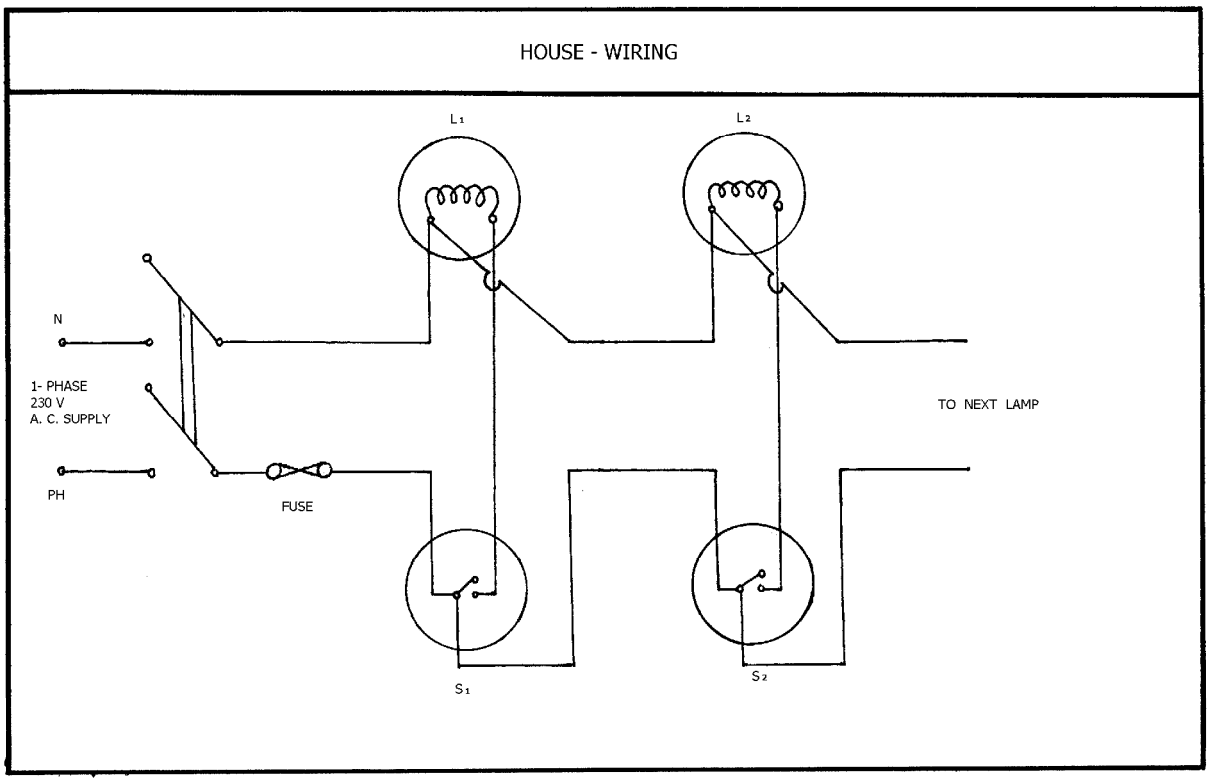
Sr. no	switch no.1	switch no.2	Lamp no.1	Lamp no.2
1.				
2.				

TESTING:

1. Connect 230V AC supply to the circuit.
2. ON switch S1 which glows Lamps L1.
3. ON switch S2 which glows Lamp L2 (If this is not happen it means that connections are somewhere wrong)

USE:

Such connections are used in house wiring. When one lamp or fan or any electrical application are controlled by one switch in an interlocked fashion.



Exercise No2: (2 Hours) – 1 Practical

Stair-case Wiring.

AIM: To control one lamp by two 2-way switches.

APPARATUS:

1. Kit Kat fuse: 1Nos. 5 Amps.
2. Single pole switch: 2 Nos. , 5 Amps
3. Lamp holders: 2 Nos. , 5 Amps
4. Lamps: 2 Nos.
5. Battens, Nails, Clips, CTS wire, Fuse wire.
6. Round wooden block: 04 Nos.
7. Square wooden block: 01 Nos.

PROCEDURE:

1. Fix the battens at suitable distance as per the circuit diagram.
2. Cut the wire of suitable sizes. Fix the clips with nails on the battens & put the wire as per circuit diagram, The wire should not cross each other on the batten.
3. Fix the wooden blocks as per correct position & complete the wiring As per circuit diagram.
4. Put fuse wire in Kitkat fuse.
5. Test the complete wiring as per testing procedure.

OBSERVATION:-

Sr. no	switch no.1	switch no.2	Lamp status

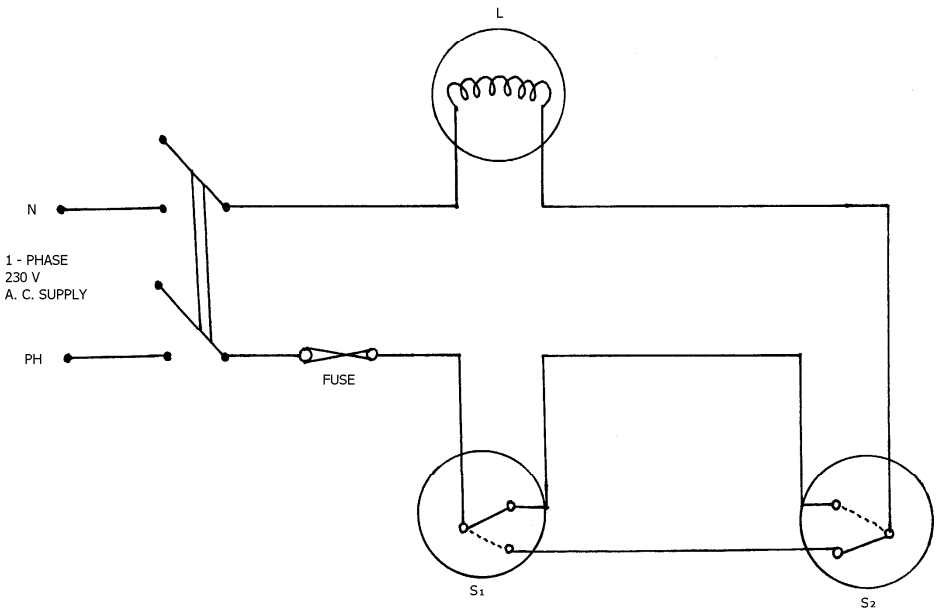
TESTING:

1. Connect 230V AC supply to the circuit.
2. ON & OFF switch S1 & check that either lamp L1 glows or not.
3. Check lamp L1 by S2.
4. ON the lamp by S1 & OFF that by S2. (If any given points in testing are not working , it means that some where connections are wrong.)

USE:

Such connections are used in house for stair-case, for double application of fan, Night lamp etc.

STAIR CASE WIRING



Exercise No3: (2 Hours) – 1 Practical

Verification of superposition theorem

AIM: To verify superposition theorem for given resistive network.

APPARATUS:

1. Ammeter D.C. (0-1A).
2. D.C. supply

PROCEDURE:

1. Make the connections as per ckt. diagram.
2. Apply source (A), & remove source B & short the terminals.
3. Take three ammeter readings (i.e. 11, 12, 13)
4. Apply source B & remove source A & short the terminals.
5. Again take the readings of ammeters.
6. Apply both sources A&B.
7. Take the readings of all ammeters.

OBSERVATION TABLE:

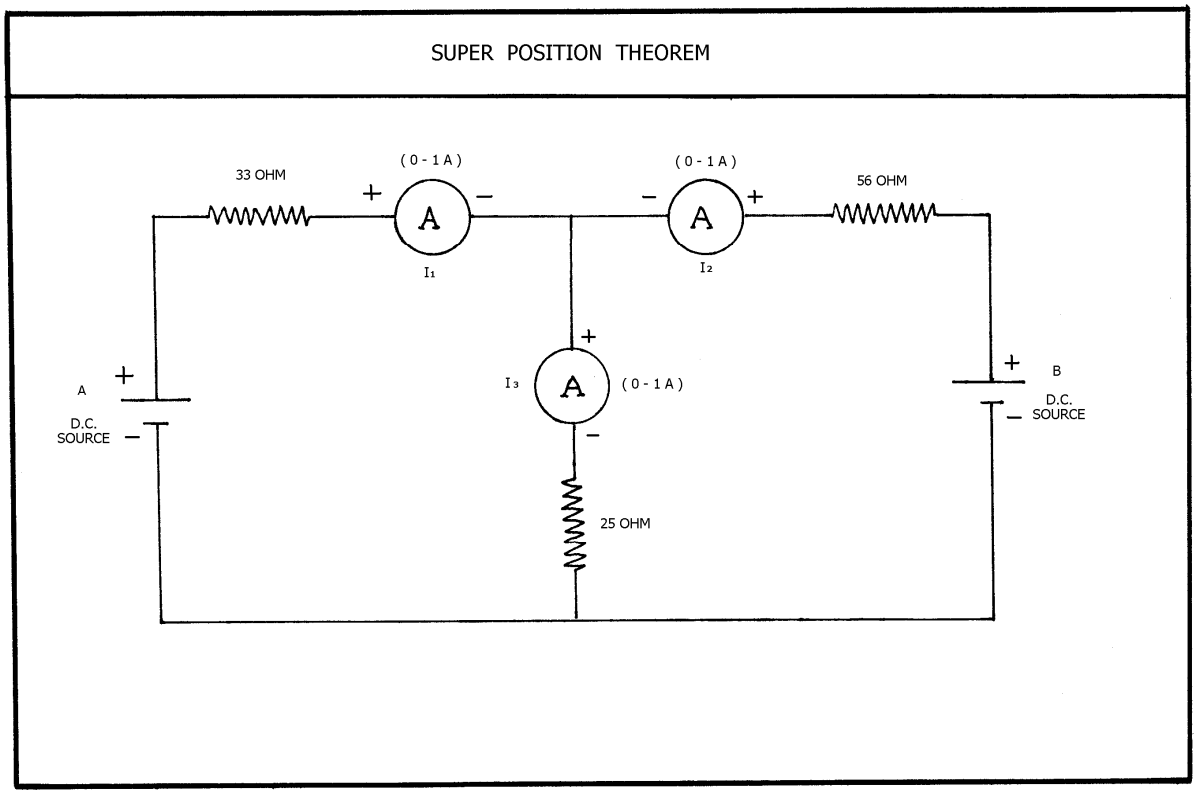
Sr. No.	Source	I_1'	I_1''	I_2'	I_2''	I
1	A					
2	B					
3	A &B					
4	A + B					

CALCULATIONS:

A & B = A + B

CONCLUSION:

Results of superposition theorem (i.e. addition of currents when A & B are individually applied is equal to the current when both sources are ON at the same time).



Exercise :

Q1. Under what conditions is the superposition theorem applicable ?

Q2. What do you mean by the term 'linear' ?

Q3. What do you mean by 'bilateral' ?

Q4. Can the superposition theorem be applied to determine 'power' in an element of a circuit ?

Q5.What do you mean by 'superposition' in this theorem ?

Exercise No4: (2 Hours) – 1 Practical

Verification of thevenins theorem.

AIM: To verify thevenins theorem for given resistive network.

APPARATUS:

1. Ammeter D.C. (0-500mA)
2. Voltmeter D.C. (0-25V)
3. Multimeter.

PROCEDURE:

1. Make the connections as per ckt. diagram (1).
2. Make the switch ON.
3. Note down the ammeter reading i.e. IL.
4. Make the connections as per ckt. diagram No. (2).
5. Give the supply & note down the voltmeter reading i.e. V_{th}.
6. Make the connections as per ckt diagram no. (3).
7. Give the supply & note down the readings of ammeter (1) & voltmeter (V)
8. Find R_{th} =V/I.
9. Calculate IL= V_{th} / (R_{th} + R_L).

OBSERVATIONS:

Sr. No.	V_{TH}	R_{TH}	R_L	I_L
1				
2				
3				
4				

CALCULATIONS:

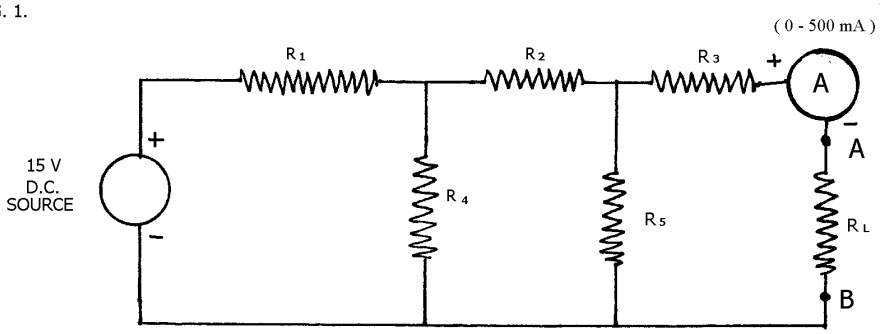
R_{th} =V / I.

IL=V_{th} / (R_{th} +R_L

CONCLUSION:

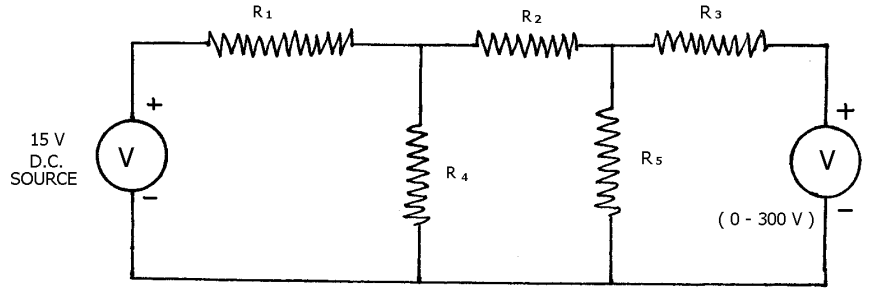
From equation I & II we conclude that current flowing through R_L is verified & found to equal directly as well as by thevenins theorem.

FIG. 1.



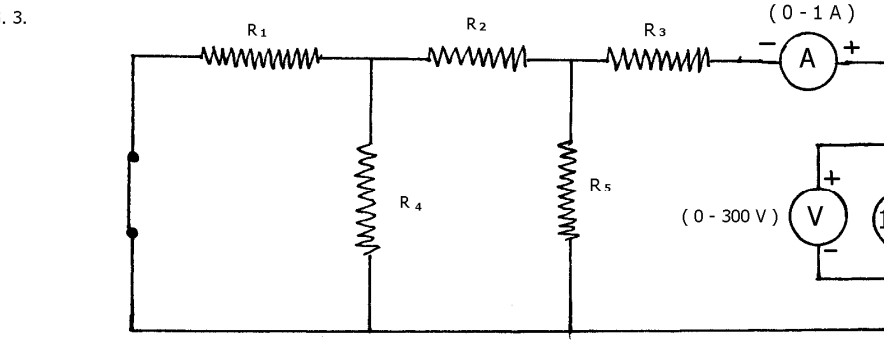
I_L = _____mA

FIG. 2.



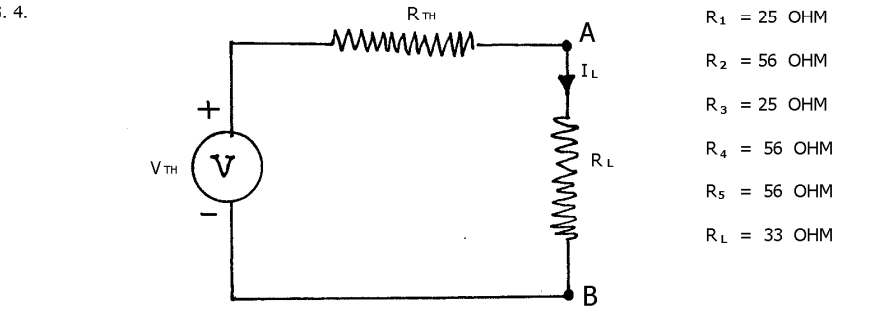
V_{TH} = _____ VOLTS

FIG. 3.



R_{TH} =_____OHM

FIG. 4.



R_1 = 25 OHM

R_2 = 56 OHM

R_3 = 25 OHM

R_4 = 56 OHM

R_5 = 56 OHM

R_L = 33 OHM

Exercise :

Q1. How do you find the thevenin's equivalent resistance ?

Q2. What do you mean by making the sources inactive ?

Q3. State the name another theorem having similar properties like thevenin's theprem ?

Q4. What is the difference between Norton's and Thevenin's theorem ?

Q5. How do you find the open circuited voltage ?

Exercise No5: (2 Hours) – 1 Practical

Measurement of power & energy.

AIM: To measure power & energy in 1-Φ AC circuit.

APPARATUS:

i. Wattmeter –(0-1200w), 1 Nos.
ii. 1-Φ Energy meter, 1 Nos.
iii. Load bank.

PROCEDURE:

1. Do the connections as per ckt. diagram.
2. Connect 230V AC supply to the circuit.
3. ON the load (kept it constant throughout the experiment)
4. Take the readings of energy meter & wattmeter.
5. After 20 minutes take the second reading of energy meter.

OBSERVATIONS:

1. Initial energy meter reading (E1)= _____ KWH
2. Final energy meter reading (E2)= _____KWH
3. Wattmeter reading (W)=_____Watts
4. Time required for final energy meter reading = 20 minutes.

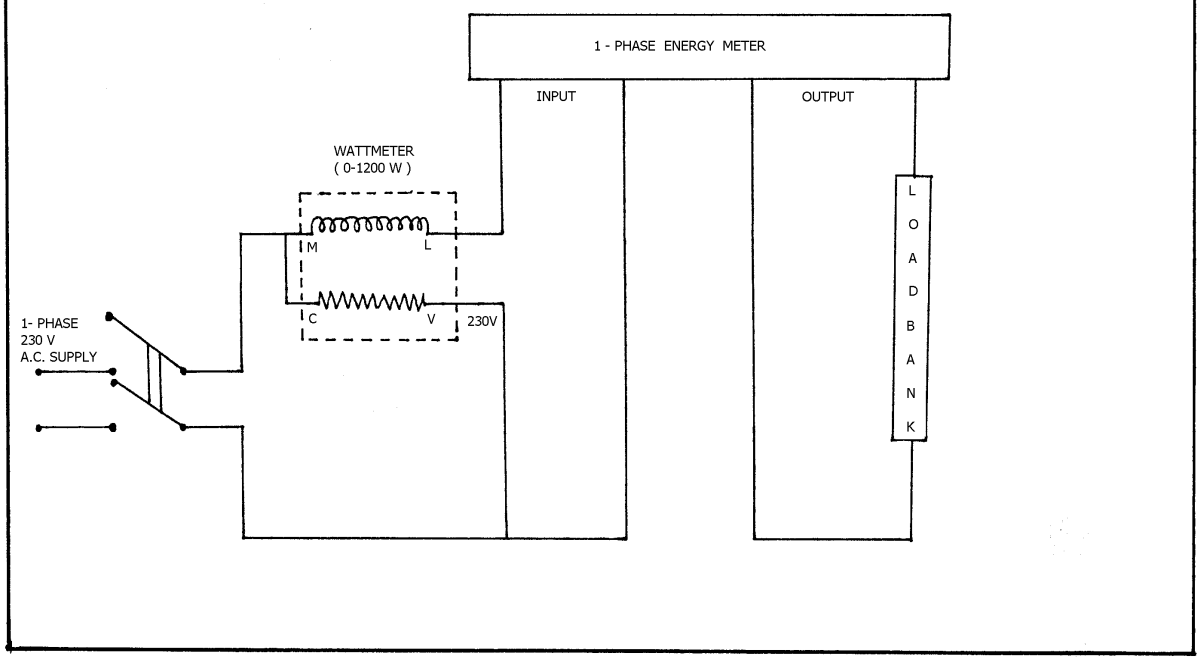
CALCULATIONS:

E= Actual energy consumed = E2-E1= _____KWH----------(I)
E=Actual energy consumed calculated from wattmeter reading & time
= W x t= _____watt minute.
= (W x t)/(1000x60) KWH----------(II)

CONCLUSION:

From equation 1 & 2 we conclude that energy actual consumed & calculated are same.

POWER AND ENERGY
MEASUREMENT



Exercise No6: (2 Hours) – 1 Practical

Fluorescent Lamp.

AIM: To study fluorescent lamp.

THEORY:

CONSTRUCTION:

The fluorescent lamp is a low pressure mercury discharge lamp. It is generally consist of a long glass tube (G) with an electrode on each end (E1 & E2). These electrodes are made of coiled tungsten filament coated with electron emitting material. The tube is internally coated with a fluorescent powder & contains small amount of argon with a little mercury at a very low pressure. The control ckt. of tube consist of a starting switch (S) known as starter, an iron cored inductive coil called a choke (L),& two capacitors C1 & C2.

OPERATION:

A starting switch namely the glow type (voltage operated device) is used in tube operation. The starter is glow type starter (S) shown in fig. Consist of two electrodes sealed in glass tube filled with mixture of Helium & Hydrogen. One electrode is fix & another is U-shaped bimetallic strip made up of two different metals having two different temperature co-efficient. Contacts are normally open.

When the supply is switched ON, heat is produced due to glow discharge between electrodes of starter is sufficient to bend bimetallic strip until it makes contact with fixed electrode. Thus ckt, between two electrode E1 & E2 is completed & relatively large current circulated through them. The electrodes are then heated to incandescence by this circulating current & gas in their immediate vicinity is ionized. After a second or two, due to absence of glow discharge a bimetallic strip cools sufficiently. This causes to break contact & sudden reduction of current induces an emf of the order of 800-1000V in choke coil. This voltage is sufficient to strike an arc between two electrodes E1 & E2 due to ionization of Organ. The heat generated in the tube vaporizes mercury & potential difference across the tube falls to 100-110V. This potential difference is not sufficient to restart glow in starter.

FUNCTION OF AUXILLARY CIRCUIT COMPONENTS:

CHOKE

1. It provides a necessary high voltage to start discharge in the tube.
2. Since the voltage required across the tube during normal operation is small, the excess voltage drop across the tube.
3. It acts as a stabilizer.

CAPACITOR(C1)

The choke lowers a power factor of the ckt. C1 connected across the supply improves this power factor.

CAPACITOR(C2)

It is connected across starting switch to suppress radio interference due to high frequency voltage oscillation which may occur across it's contacts.

ADVANTAGES:

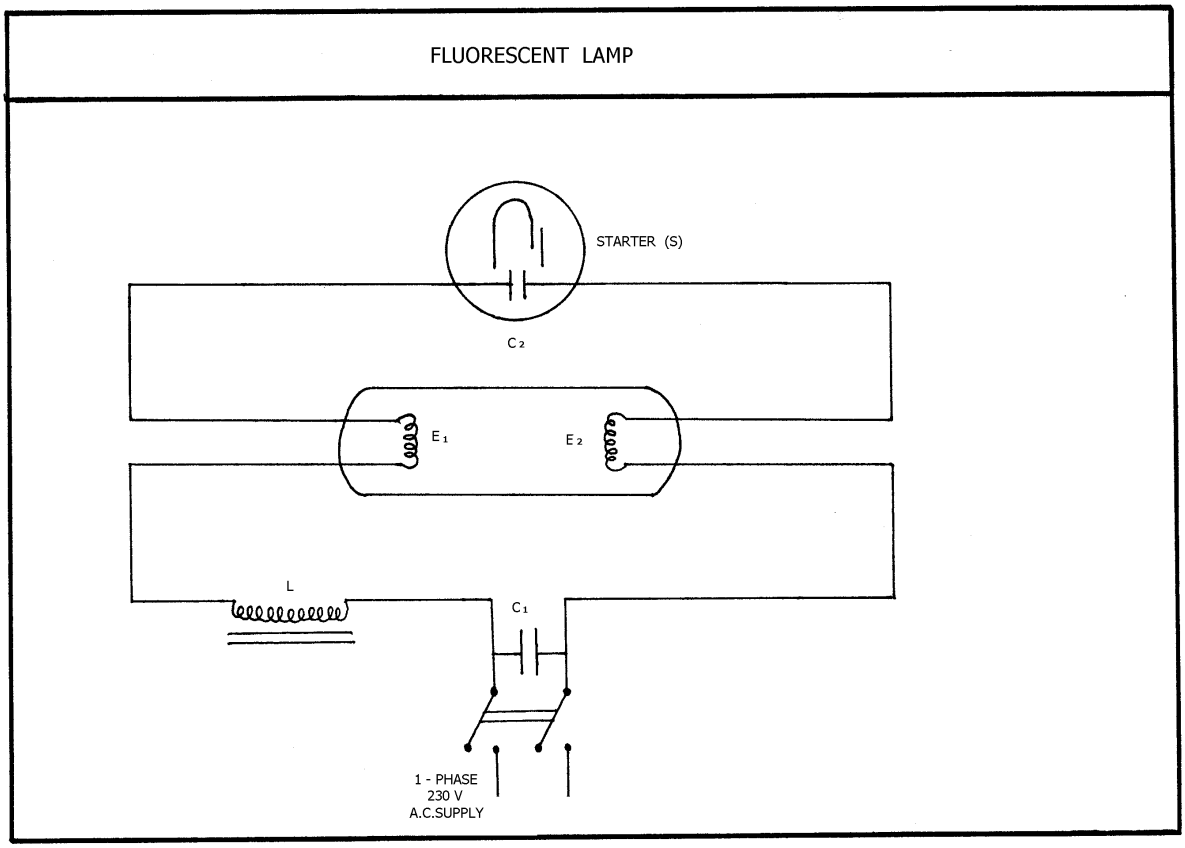
1. Low power consumption.
2. Longer life which is about 3 to 4 times that of the filament life.
3. Compared to filament lamp efficiency is also about 3 to 4 times, it gives more light for the same wattage.
4. Superior quality of light.
5. No warming up period is required as in case of another discharge lamp.
6. Different colour light can be obtained, by using different types of fluorescent powder.
7. Low heat radiation.

DISADVANTAGES:

1. Initial cost of the lamp along with auxiliary equipment needed is very high
2. With frequent operation life reduces.
3. Voltage fluctuation affect it but not to the extent that filament lamp is affected.
4. Produce radio interference.
5. Fluctuating light output produces undesirable stroboscopic effect with rotating machinery.

APPLICATION:

They are very popularly used for interior light in residential buildings, shops & hotels. They are also extensively used with reflectors for street lightings. Due to their glare free shadow less light, they are ideal for workshop, factories, laboratories & drawing rooms. The fluorescent tubes are normally manufactured with 20,40 & 80 watts.


FLUORESCENT LAMP
STARTER (S)
C2
E1
E2
L
C1
1 - PHASE
230 V
A.C.SUPPLY

Exercise No7: (2 Hours) – 1 Practical

Voltage and Current ratio of 1-phase transformer.

AIM: To determine Voltage & Current ratio of 1-Φ transformer.

APPARATUS:

i. Ammeter A.C. (0-10 A)----------2 Nos.
ii. Voltmeter A.C. (0-300V)----------2Nos.
iii. 1-Φ Transformer.
iv. Load Bank.

PROCEDURE:

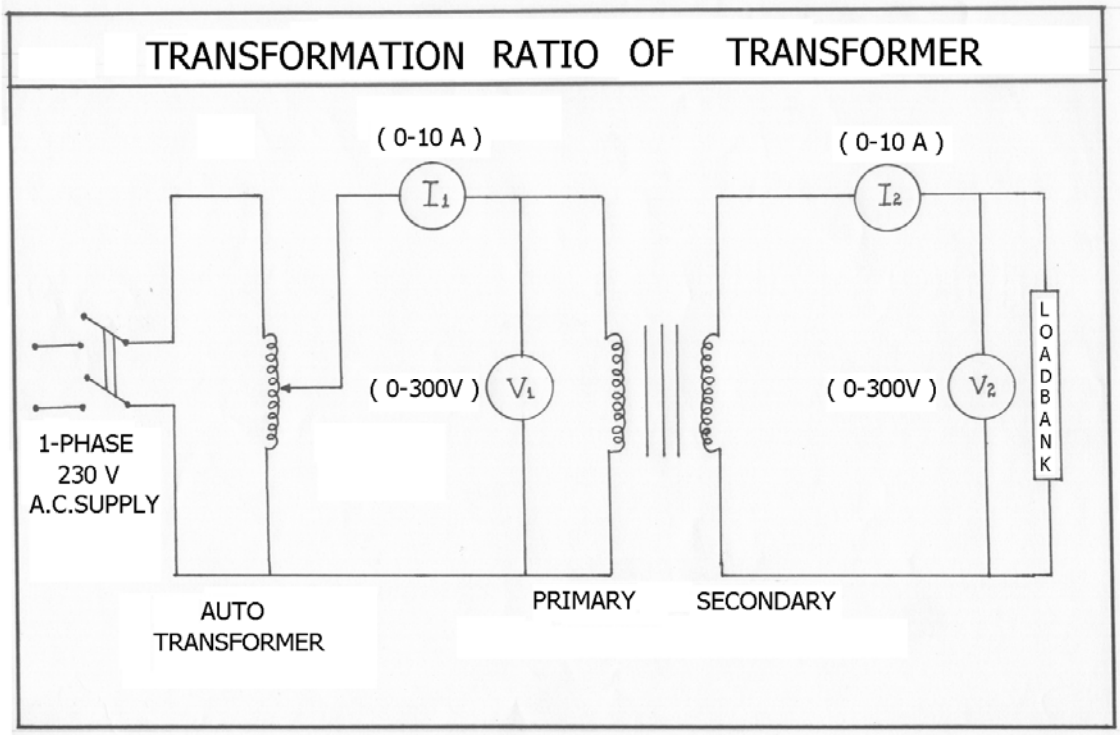
1. Make the connection as per circuit diagram.
2. Give supply to 1-Φ transformer through auto-transformer.
3. Take no load reading of V2, V1, I2, I1.
4. Increase load in steps and gradually take the readings of voltmeters and Ammeters.
5. Find Voltage and Current ratio.
6. Plot the graph of a) I1 v/s I2. b) V1 v/s V2.

OBSERVATION TABLE:

Sr. No.	Primary Voltage (V1)	Primary Current (I1)	Secondary Voltage (V2)	Secondary Current (I2)	V2 / V1	I1 / I2
1.						
2.						
3.						

CONCLUSION:

From Graph, Voltage and Current ratio we conclude that transformation ratio K= slope of the graph as well as Voltage and Current ratio is constant for 1-Φ transformer.


TRANSFORMATION RATIO OF TRANSFORMER
(0-10 A)
I1
(0-10 A)
I2
(0-300V)
V1
(0-300V)
V2
LOADBANK
1-PHASE
230 V
A.C.SUPPLY
AUTO
TRANSFORMER
PRIMARY
SECONDARY

Exercise No8: (2 Hours) – 1 Practical

RLC SERIES A.C. CIRCUIT.

AIM: To determine power factor of RLC series circuit.

APPARATUS:

i. Ammeter A.C.(0-1A), 1 No.
ii. Voltmeter A.C.(0-500V), 1 No.
iii. Wattmeter- (0-1200W)(5A,440V), 1 No.
iv. Resistance (300Ω/1.7Amp)
v. Capacitor, Choke

PROCEDURE:

1. Make the connections as per circuit diagram.
2. Give the supply to circuit.
3. Take the reading of Ammeter, Wattmeter & Voltmeter.
4. Plot voltage triangle by using VR, VL & VC.
5. Calculate power factor for ckt.

OBSERVATION:

1. Ammeter reading ---------- = I = _____ Amp.
2. Wattmeter reading ---------- = W= P= _____Watts
3. Supply Voltage ----------= V = _____ Volts.
4. Voltage across resistance----------=VR= _____ Volts.
5. Voltage across capacitor----------=VC=_____ Volts.
6. Voltage across inductor (choke)----------=VL=_____Volts.

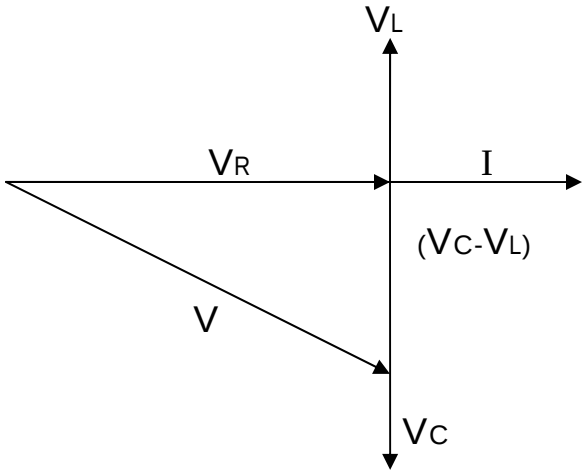
CALCULATIONS:

Active power = Wattmeter reading
P = W = VI cosΦ.
Cos Φ = Wattmeter reading (W) / Supply voltage (V) X Ammeter reading.

VOLTAGE TRIANGLE:

From voltage triangle ,

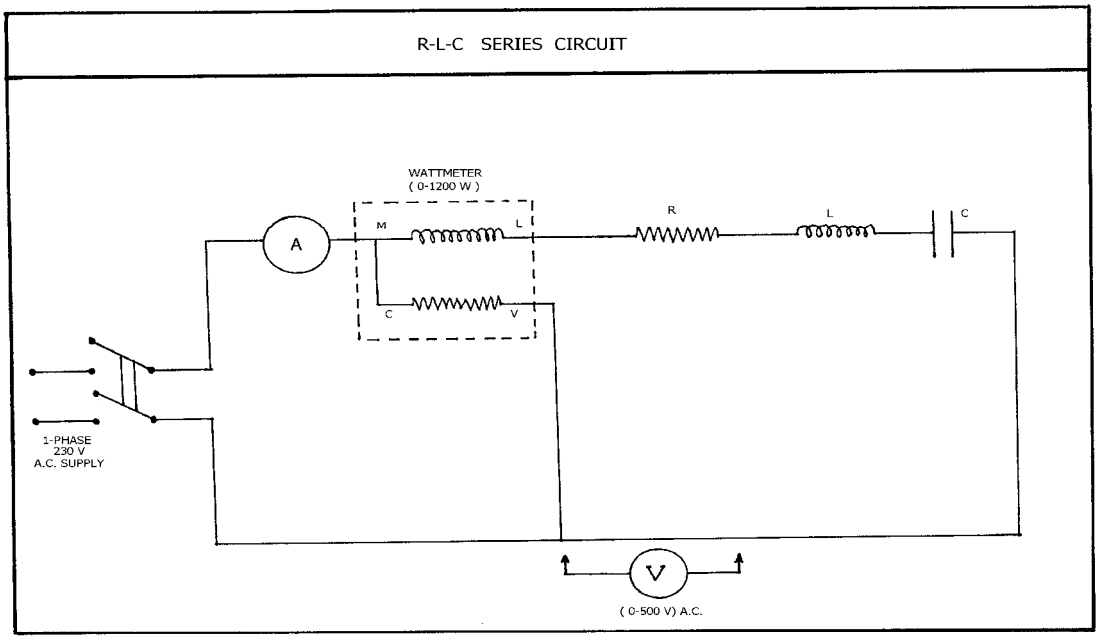
Power Factor (cos Φ) = _____ Leading . If Vc > VL



CONCLUSION:

Power factor of the RLC circuit is obtained as = _____ lead (from voltage triangle)
From this we conclude that ckt. is capacitive in structure because power factor is leading.

Circuit diagram:-



Exercise No9: (2 Hours) – 1 Practical

MULTIMETER

AIM: To study multimeter and testing of different components.

APPARATUS: Multimeter.

THEORY :

A multimeter is an instrument designed to measure two or more electrical quantities such as voltage , current & resistance. Basically two types of multimeters are used: analog & digital. Now a days mostly digital multimeters are preferred. In addition with above quantities advance digital multimeters are used for checking diode, transistor as well as capacitance measurement.

CONSTRUCTION :

It consists of moving coil instrument, a no of ammeter shunts, voltmeter multipliers, rectifier and selector switches all in single casing. Selection of particular mode of measurement required (i.e. D.C. or A.C.)is effected by function selector switch & range selector switch can be set to give a choice of several ranges of current, voltage & resistance. A suitable protection is provided to the meter movement against possible overload during it's use.

OPERATION :

Circuit diagram shows basic circuitry of multimeter for the measurement of different electrical quantities. A multiplier provides a high voltage range while shunt resistance provides higher current range. A series rectifier make the measurement of A.C. voltage possible with the same D.C. meter movement. Thus the same scales are used for both A.C. & D.C. current & voltage. For resistance measurement a set of voltage from an internal battery is applied across the resistance & resulting current is measured. By Ohm's law, this current being inversely proportional to the resistance, scale is calibrated to give directly resistance in ohms to use. The resistance scale is exactly reverse of the current scale i.e. full scale deflection of pointer corresponds to maximum current in the range but on the resistance scale it corresponds to zero resistance.

Even through the total ckt of multimeter is complex fig. A to fig. D shows separately the simplified ckt diagram of different sections of typical multimeter ckt. Used for various measurements. This fig. Is more or less self explanatory.

PROCEDURE :

1. Measure unknown D. C. voltage , A. C. voltage by connecting multimeter across the ckt.
2. Measure D.C. current and A.C. current by connecting multimeter in series with ckt.
3. Measure resistance and capacitance directly with out connecting supply.
4. Check Transistor & diode on multimeter.

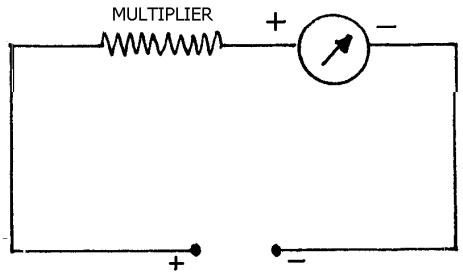
OBSERVATIONS :

1. Value of unknown resistance =R = _____ohms.
2. Value of voltage across D.C. supply =V_1 =_____Volts
3. Value of voltage across A.C. supply =V_2 =_____Volt
4. Value of unknown capacitor =C = _____farad.
5. Value of A.C. current in the ckt =I_1 = _____Amps.
6. Value of D.C. current in the ckt = I_2 = _____Amps

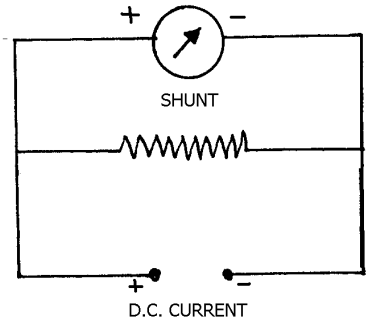
APPLICATIONS :

Being portable and compact instrument, multimeters are widely used in fields, shops & laboratories to measure a wide range of D.C. Voltage & currents. A. C. voltage & currents, resistance and capacitance measurements. It is also used to check continuity of conductors and windings.

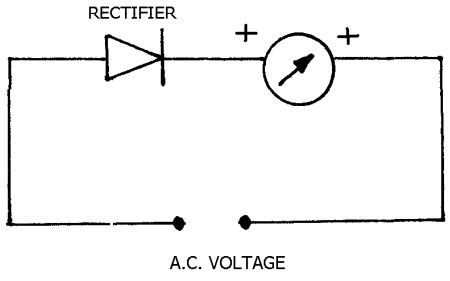
A) D.C. VOLTAGE MEASUREMENT



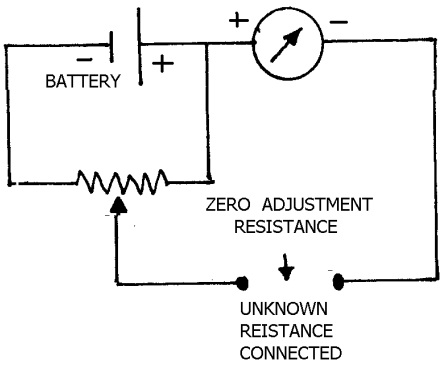
B) D.C. CURRENT MEASUREMENT



C) A.C. VOLTAGE MEASUREMENT



D) RESISTANCE MEASUREMENT



Exercise No10: (2 Hours) – 1 Practical

Earth Tester.

AIM: To measure the Earth Resistance.

APPARATUS:

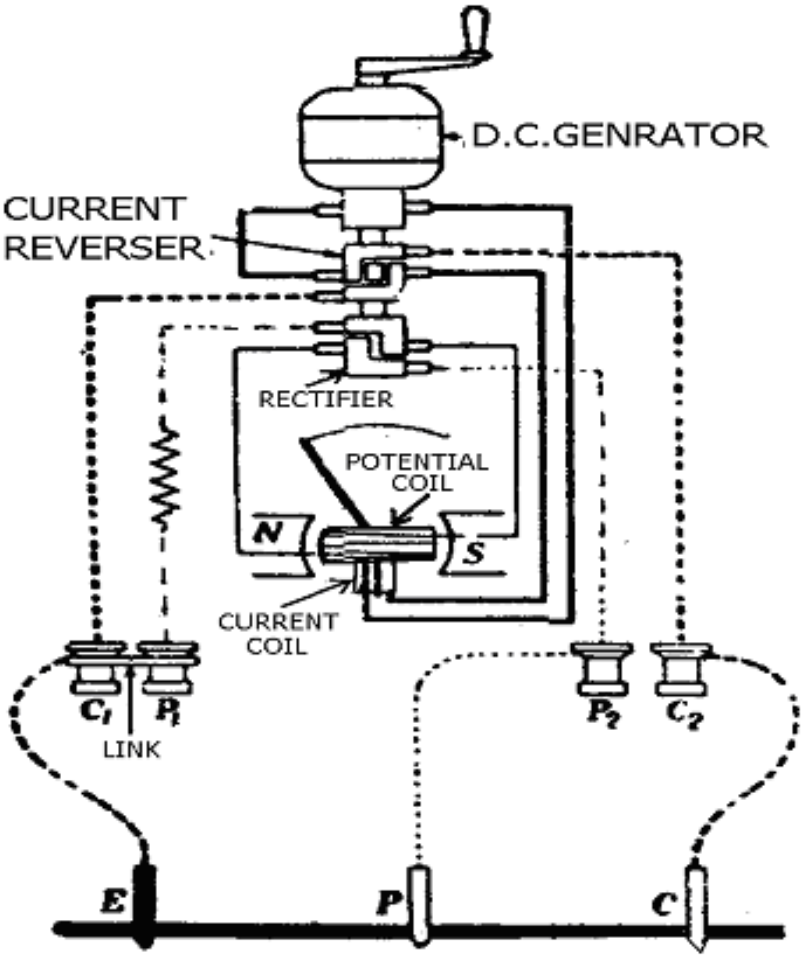
1. Earth Tester-1 no.
2. Spikes --2 No.s

PROCEDURE:-

1) Put the two spikes acting as current & potential electrode in to the ground at a distance of 25 m & 12.5 m from earth electrode under test.
1) Connect the two spikes to C2 & P2 terminals respectively.
2) Short the P1 & C1 terminals of motor & connect it to the earth electrode under test.
3) Place the megger on horizontal firm stud.
4) Turn the handle of megger to speed slightly higher then rated speed & note down the deflection of the needle.
5) Take down the 3 to 4 readings by keeping the distance same and placing the electrodes at the other positions.
6) Take the average of these readings which is equal to earth resistance.

CONCLUSION:-

The value of earth resistance by direct method is ---------- Ω.



Earth tester circuit

3. Quiz on the subject:

1) To control two lamp by two separate switches.
   A) Why switches are placed in mains?
   B) Whether switches are connected in series with load/ lamp or across the lamp.
   C) Why the switches are rated in amperes?
   D) Why fuse is used?
   E) What material is used as fuse wire?

2] To control one lamp by two switches.
   F] Which type of switch is used in this circuit?
   G] Where this circuit is applicable?
   H] It is also known as staircase wiring, why?

2) Verification of superposition theorem .
   A] State the superposition theorem.
3) Thevenin's theorem(verification)
   A) State the thevenin's theorem
4) Measurement of power and energy in single phase circuit.
   A) Power in a.c. circuit is given by? What is the unit of measuring power?
   B) Energy in a.c. circuit is given by? What is the unit of energy?
   C) Which meter is used to measure power and energy?
5) Fluorescent lamp.
   A] What is the function of choke?
   B] What is the function of starter?
   C] Why capacitor is connected across the supply.
   D] What is the difference between fluorescent lamp & incandescent lamp
   E] What is C.F.L. lamp.
6) To determine voltage and current transformation ratio of single phase x'mer.
   A) What is the working principle of the Transformer.
   B) Transformation ratio depends on which factor.
   C) Why transformers are rated in KVA?
   D) Application of single phase transformer?
7) To determine p.f. of RLC series circuit?
   A] Why current is leading the voltage in capacitors?
   B] Why current is lagging the voltage in inductor?
   C] What is the p.f. of resistive circuit.
   D] What is resonance?
   E] What is condition for resonance?
8) Multimeter
   A] What is the current range of multimeter?
   B] How we can measure the different quantity by using single meter?
   C] Why it is known as multimeter?
   D] What is the function of multiplier & shunt?
   E] How the continuity of wire is checked by the meter.

4. Conduction of Viva-Voce Examinations:

Teacher should oral exams of the students with full preparation. Normally, the objective questions with guess are to be avoided. To make it meaningful, the questions should be such that depth of the students in the subject is tested Oral examinations are to be conducted in co-cordial environment amongst the teachers taking the examination. Teachers taking such examinations should not have ill thoughts about each other and courtesies should be offered to each other in case of difference of opinion, which should be critically suppressed in front of the students.

5. Evaluation and marking system:

Basic honesty in the evaluation and marking system is absolutely essential and in the process impartial nature of the evaluator is required in the examination system to become popular amongst the students. It is a primary responsibility of the teacher that right students who are really putting up lot of hard work with right kind of intelligence are correctly awarded.

The marking patterns should be justifiable to the students without any ambiguity and teacher should see that students are faced with unjust circumstances.