BIRLA INSTITUTE OF TECHNOLOGY PATNA

DEPARTMENT OF ELECTRICAL AND ELECTRONICS

Basic Electrical Engineering Lab (EE3202)

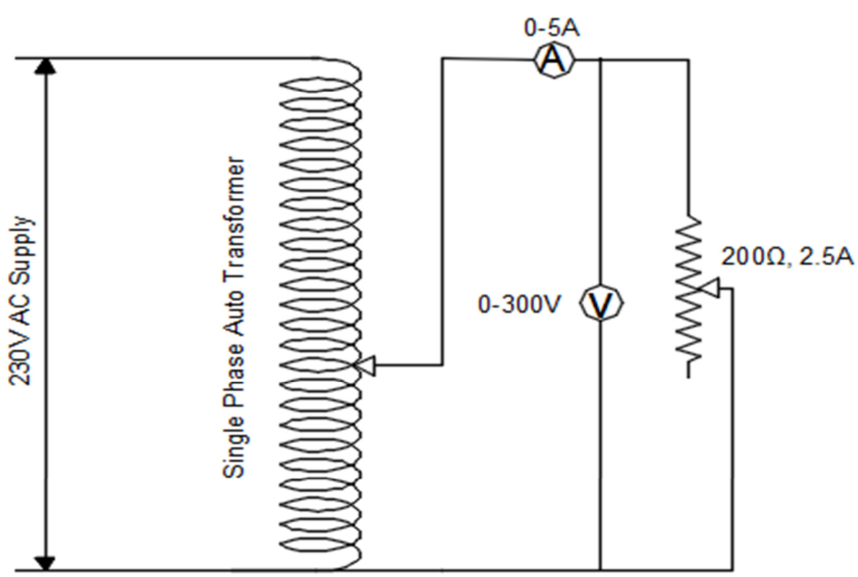
Experiment 1: To verify ohm's law.

Object: To find relation between current and voltage in a closed circuit consisting resistive load.

Description: Ohm's Law is the mathematical relationship among electric current, resistance, and voltage. The principle is named after the German scientist Georg Simon Ohm. In direct-current (DC) circuits, Ohm's Law is simple and linear. Suppose a resistance having a value of *R* ohms carries a current of *I* amperes. Then the voltage across the resistor is equal to the product *IR* provided temperature remains constant. For many conductors of electricity, the electric current which will flow through them is directly proportional to the voltage applied to them. When amicroscopic view of Ohm's law is taken, it is found to depend upon the fact that the drift velocity of charges through the material is proportional to the electric field in the conductor. The ratio of voltage to current is called the resistance, and if the ratio is constant over a wide range of voltages, the material is said to be an "ohmic" material. If the material can be characterized by such a resistance, then the current can be predicted from the relationship:

Current I= V/R

Circuit Diagram



Circuit digram of Verification of Ohms Law

Observation table:

S.NO	VOLTMETER READING	AMMETER READING	R=V/I(Ω)	MEAN VALUE OF R(Ω)

Result: Mean value of R is equal to...........Ω.

Procedure:

1. Note down the specification, type and range of all measuring instruments.
2. Make the connection as given in circuit diagram
3. Get your connection checked by instructor.
4. Perform the experiment by varying the rheostatic resistance.
5. Perform the calculations.

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Basic Electrical Engineering Lab (EE3202)

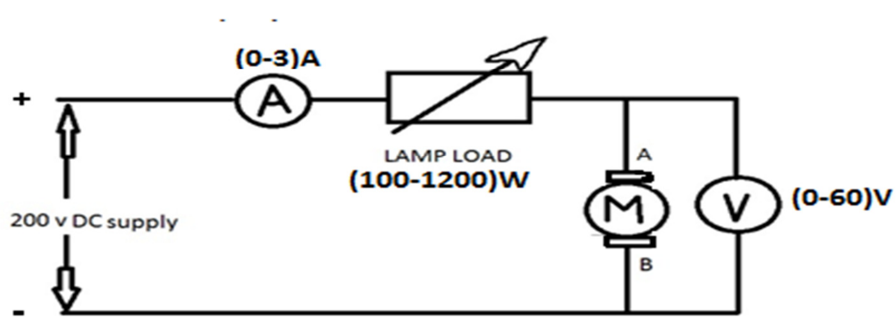
Experiment 2: To find the armature and field winding resistance of DC motor

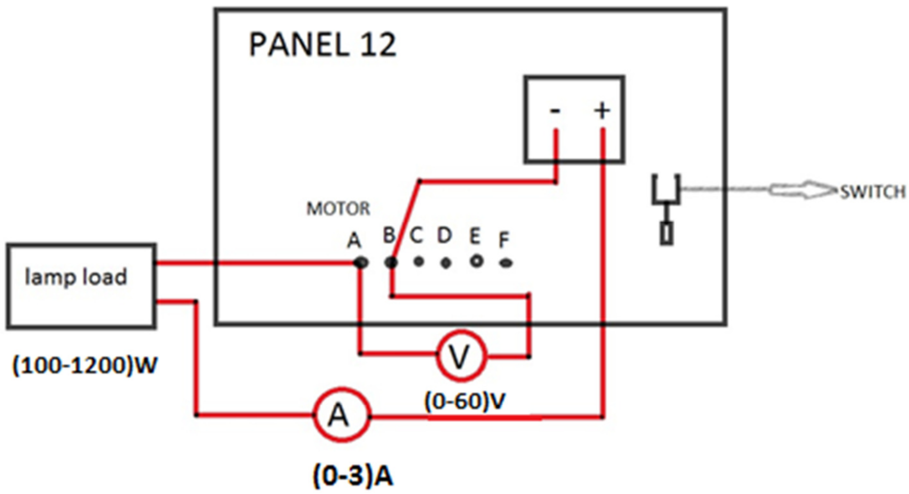
Object: DC motor winding resistances are to be measured using Ammeter-Voltmeter method

Description: A DC motor in simple words is a device that converts direct current (electrical energy) into mechanical energy. It's of vital importance for the industry today, and is equally important for engineers to look into the working principle of DC motor in details. This DC or direct current motor works on the principal of induction. When a current carrying conductor is placed in a magnetic field, it experiences a torque and has a tendency to move. The very basic construction of a DC motor contains a current carrying armature which is connected to the supply end through Commutator segments and brushes. Armature winding acts as current carrying conductor. Another winding called field winding generates the desired magnetic field when supplied by a DC source. In this experiment, the aim is to find the resistances of armature and field windings using Ammeter-Voltmeter method. Ammeter-Voltmeter method is very popular method for measurement of medium resistances since instruments required for this method are usually available in laboratory. In this method if readings of ammeter and voltmeter are taken, then we can measure value of resistance by using formula:

Resistance R= (Voltmeter reading/ Ammeter reading) = V/I

Circuit Diagram:





Instruments required

SR. NO.	EQUIPMENT	TYPE	QUANTITY	RANGE
1	AMMETER	DC	1	0-5 A
2	VOLTMETER	DC	1	0-30 V
3	LAMP LOAD	DC	1	100-1200 W
4	FLEXIBLE WIRE	-	6	-

Procedure:

1. Note down the specification of the machine under experiment.
2. Note down the range and type of all measuring instruments
3. Make the connection as given in circuit diagram. Provide supply across A-B terminal.
4. Get your circuit connection checked by instructor.
5. Switch on the supply.
6. Change the lamp load by switching lamps one by one.
7. Note down the reading and perform the calculation to find armature resistance.
8. Repeat the same experiment for field winding resistance. This time provide the supply across C-D terminal.

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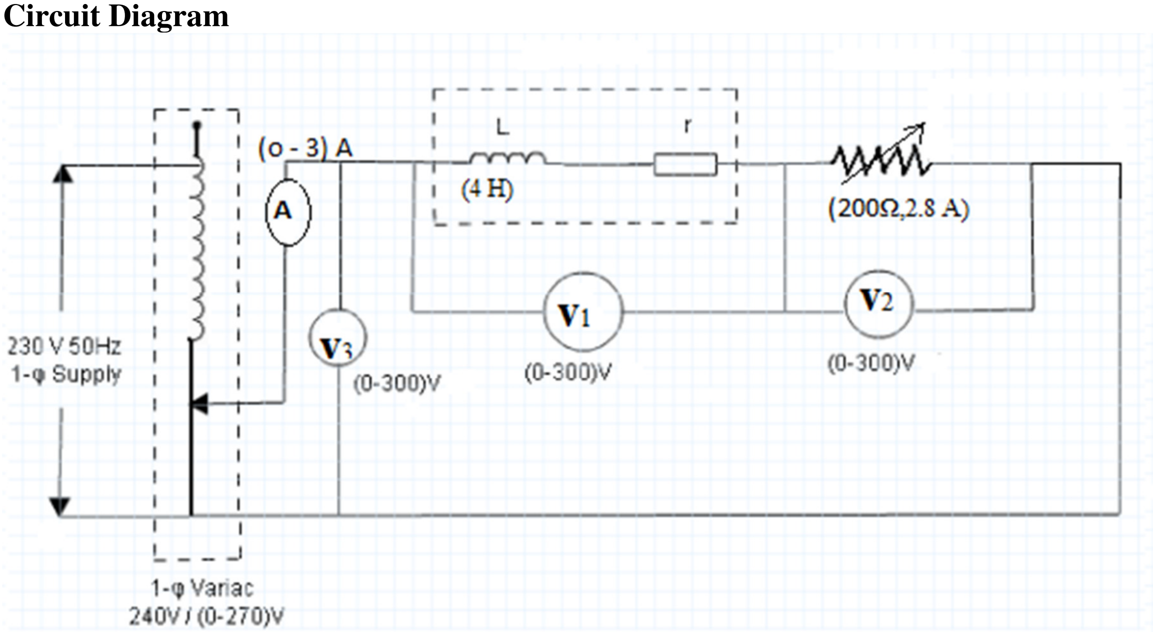
Experiment 3: Measurement of power, power factor and choke coil parameters using three voltmeter method

Object: To measure the single phase power in a single phase a.c. circuit, find the power factor of the circuit and choke coil parameters.

Description: As we know, wattmeters are used for measurement of power in inductance AC circuits, but in some cases it is not possible to use wattmeters because of their incorrect readings or sometime wattmaters may not available. So in such cases three voltmeter method is used for measurement of power. Similarly, measuring the power factor (also called cos φ) is something that we often need to do when dealing with AC mains circuits. Ideally, every load connected to the mains supply should have a cos(φ) of 1, but many devices like electric motors or old fluorescent tube ballasts are inductive and have a lower power factor. To correct the power factor, usually a capacitor of suitable value is connected in parallel. But to verify that the capacitor effectively corrects the power factor, there is no other way around than measuring it.

Circuit Diagram



Formula Used:

Power factor of the circuit: Cos $\phi = (V_3^2 - V_2^2 - V_1^2) / 2 V_1 V_2$

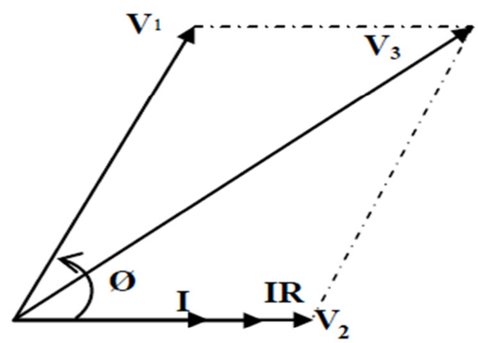
Power consumed by inductive load: $P = (V_3^2 - V_2^2 - V_1^2) / 2R$

Voltage $V_2 = IR$, find R

$V_1 = I(\sqrt{r^2 + \omega^2 L^2})$, find r

Quality factor of the choke coil $Q = \frac{\omega L}{r}$

Phasor Diagram



Phasor diagram of the above circuit.

Procedure:

1. Make the connections as per the circuit diagram. Get your checked by instructor.
2. Keep the variac at zero position before starting the experiment.
3. Switch on A.C supply.
4. By varying the variac, note the readings of the voltmeters for a given value of current.
5. Vary the current readings to obtain different readings of voltmeters.
6. Repeat step 5 for different observations.
7. Set the variac at zero position and switch off supply.

Observation table:

S. no.	Ammeter reading (A) 0 – 3 A	Voltmeter reading (V_1) 0 – 300 V	Voltmeter reading (V_2) 0 – 150 V	Voltmeter reading (V_3) 0 – 300 V

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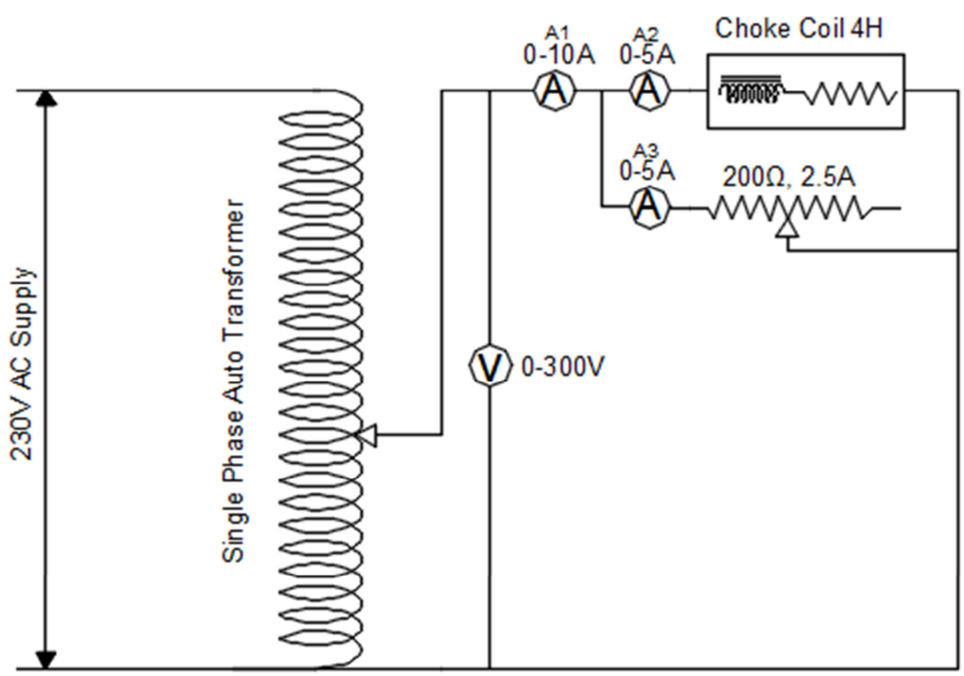
Basic Electrical Engineering Lab (EE3202)

Experiment 4: To find the power, power factor and choke coil parameters associated with single phase AC circuit using three ammeter method

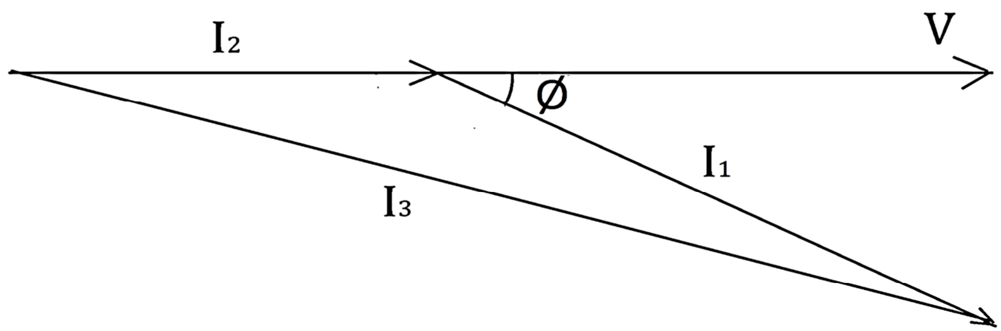
Description: Our aim here is to measure the power and power factor associated with a single phase AC circuit consisting a choke coil and a resistance. Inductance and inherent resistance of a given choke coil determine its quality factor which is an important parameter of performance. Usually, any given choke coil is represented by a pure inductance (L) in series with equivalent resistance (r). The equivalent resistance takes into effect the iron losses in the core of choke coil and its inherent resistance as well. By using 3-Ammeter method, we can efficiently measure the power, power factor and choke coil quality factor.

Circuit Diagram



Circuit digram of 3 Ammeter Method

Phasor Diagram



Formula Used:

Power factor: Cos Ø= $(I_1^2 – I_2^2 - I_3^2)/2I_2I_3$

Power consumed by inductive load: $P = R * (I_1^2 – I_2^2 - I_3^2)/2$

$V=I_3 R$, find R

$V = I_2\sqrt{r^2 + (\omega L)^2}$ find r

Quality factor $Q = \frac{\omega L}{r}$

Observation Table

S.NO.	VOLTMETER READING(V)	AMMETER READING (I_1)	AMMETER READING(I_2)	AMMETER READING(I_3)

Procedure:

1. Make the connections as per the circuit diagram. Get your checked by instructor.
2. Keep the variac at zero position before starting the experiment.
3. Switch on A.C supply.
4. By varying the variac, note the readings of the voltmeters for a given value of current.
5. Vary the current readings to obtain different readings of voltmeters.
6. Set the variac at zero position and switch off supply

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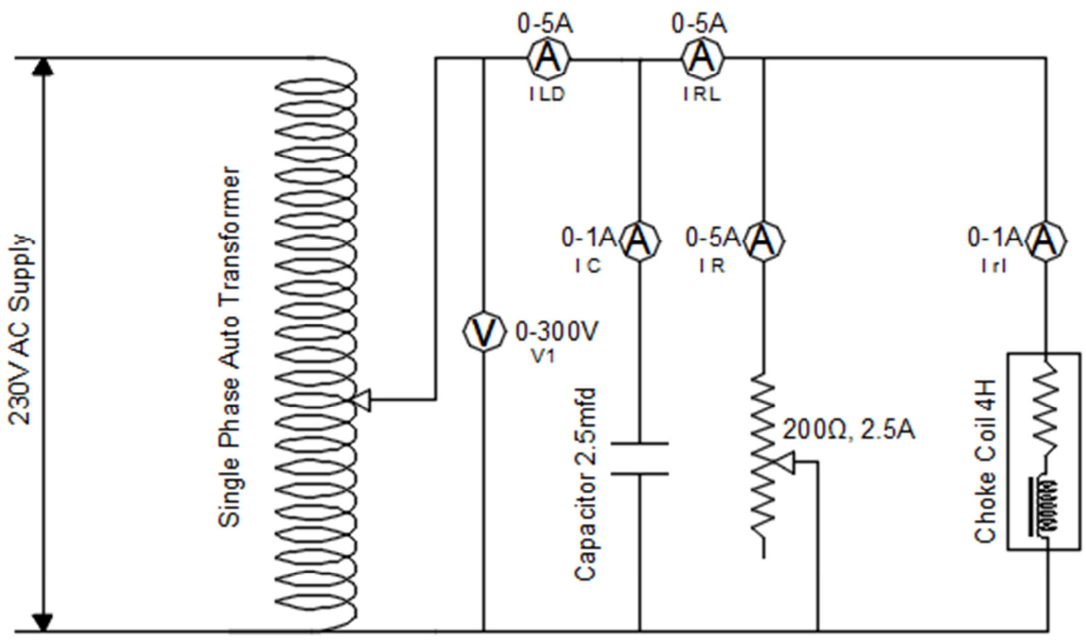
Basic Electrical Engineering Lab (EE3202)

Experiment 5: Study of the behavior of a parallel R-L-C circuit

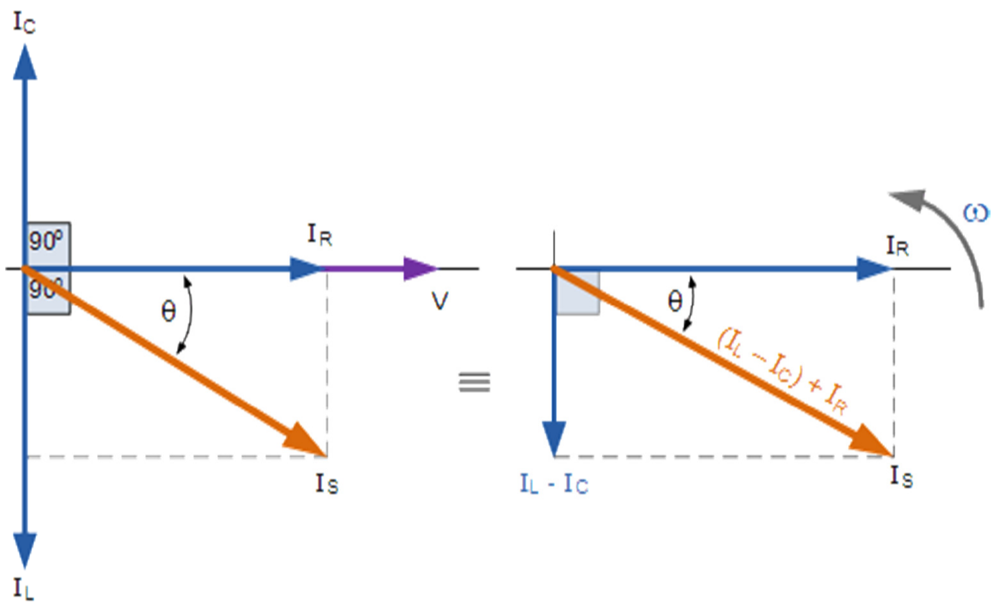
Description: In many ways a **parallel resonance** circuit is exactly the same as the series resonance circuit we looked at in the previous tutorial. Both are 3-element networks that contain two reactive components making them a second-order circuit, both are influenced by variations in the supply frequency and both have a frequency point where their two reactive components cancel each other out influencing the characteristics of the circuit. Both circuits have a resonant frequency point. The difference this time however, is that a parallel resonance circuit is influenced by the currents flowing through each parallel branch within the parallel LC tank circuit. A **tank circuit** is a parallel combination of L and C that is used in filter networks to either select or reject AC frequencies.

Circuit Diagram



Circuit digram of RLC Parallel Circuit

Phasor daiagram:



Formula Used:

Admittance, $\boldsymbol{Y = G + B_L + B_C}$

Alternatively, $\boldsymbol{Y = \frac{1}{R} + \frac{1}{J\omega L} + J\omega C}$

Resonance frequency $\boldsymbol{f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}}$ **Hz**

PROCEDURE:-

1. The connections are made according to the circuit diagram.
2. One end of the Voltmeter (V) is connected to the positive end of Auto Transformer while the other end of the voltmeter (V) is connected to the other end of the Auto Transformer.
3. Now the positive end of Auto Transformer is connected to the ‘I_L’ and the ‘I_L’ is later connected to the terminals of ‘I_C’ and ‘I_{RL}’.
4. Similarly ‘I_{RL}’ is connected to the terminals of ‘I_R’ and ‘I_{rL}’.
5. ‘I_L’ is connected to the capacitor and then to the rheostat, ‘I_{rL}’ to the choke coil and then to the rheostat and ‘I_R’ directly to the rheostat.
6. And finally rheostat is connected to the negative terminal of the Auto Transformer.
7. Now by switching it on, we observe different currents in the branches according to the applied voltage and is noted down.

Observation Table:

S.No.	V_{Line}(V)	I_{Line}(A)	I_C(A)	I_{RL}(A)	I_R(A)	I_{rL}(A)
1						
2						
3						
4						
5						

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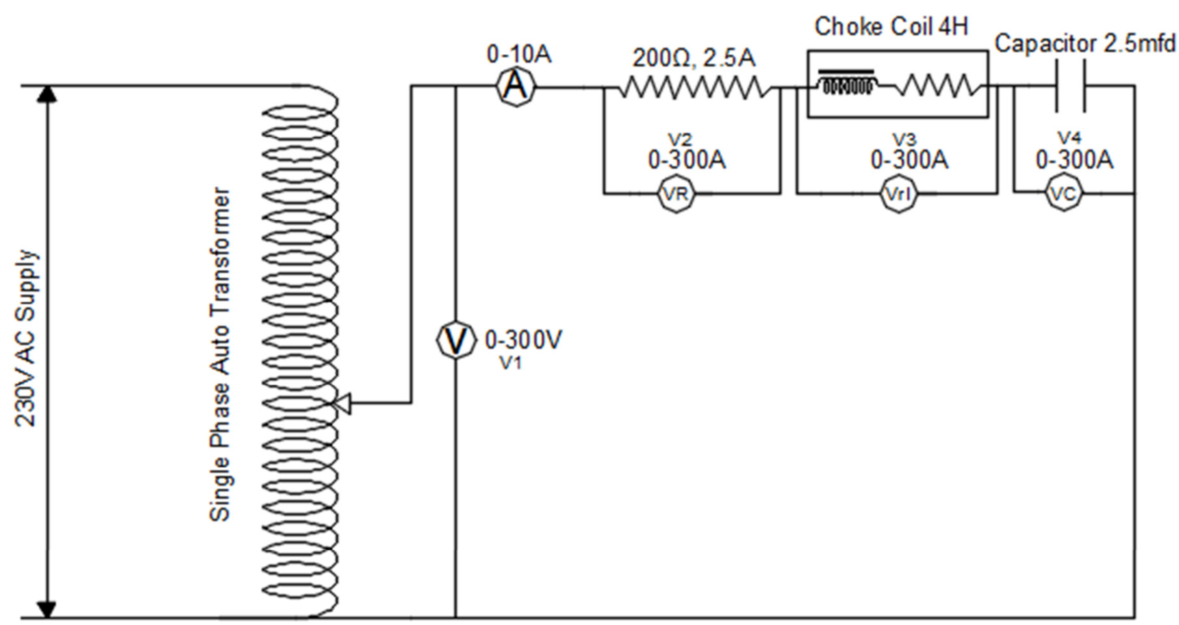
Basic Electrical Engineering Lab (EE3202)

Experiment 6: Study of the behavior of a series R-L-C circuit

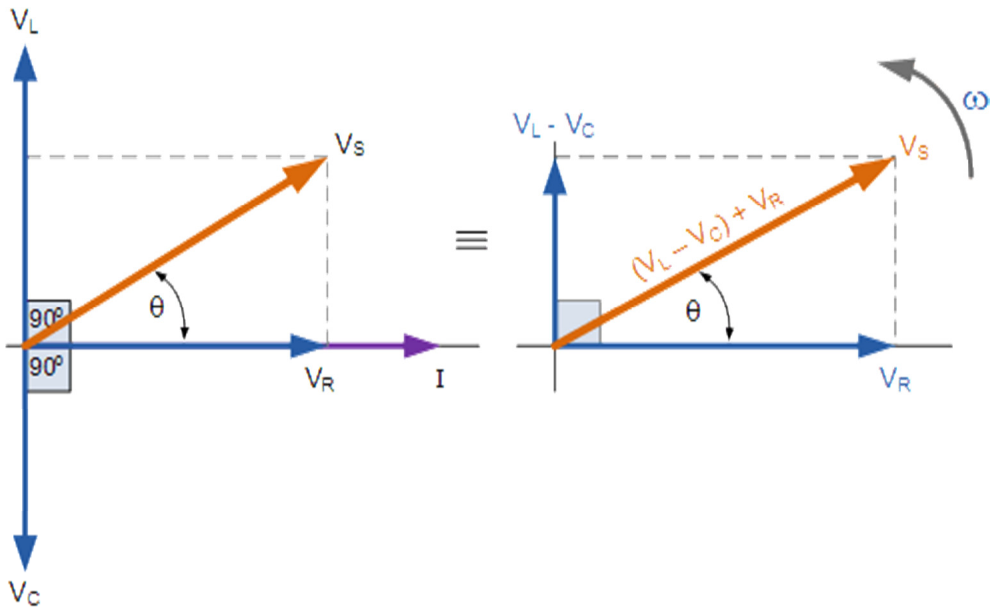
Description: The series RLC circuit has a single loop with the instantaneous current flowing through the loop being the same for each circuit element. Since the inductive and capacitive reactance's X_L and X_C are a function of the supply frequency, the sinusoidal response of a series RLC circuit will therefore vary with frequency, f. Then the individual voltage drops across each circuit element of R, L and C element will be "out-of-phase" with each other. The amplitude of the source voltage across all three components in a series RLC circuit is made up of the three individual component voltages, V_R, V_L and V_C with the current common to all three components. The vector diagrams will therefore have the current vector as their reference with the three voltage vectors being plotted with respect to the reference.

Circuit Diagram:



Circuit digram of RLC Serries Circuit

Phasor Diagram:



Formula used:

$$V_S = V_R + V_L + V_C$$

$$Z = R + J\omega L - J\omega C = \sqrt{R^2 + ((\omega L)^2 - \frac{1}{(\omega C)^2})}$$

Resonance frequency $f_R = \frac{1}{2\pi\sqrt{LC}}$

Observation table;

S.No.	I(A)	V_L(V)	V_R(V)	V_{rl}(V)	V_C(V)	V_{RL}(V)

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Basic Electrical Engineering Lab (EE3202)

Experiment 7: To find the voltage transformation ratio of 1-φ transformer

Description: A transformer is a static machine used for transforming power from one circuit to another without changing frequency. This is a very basic **definition of transformer**. Since there is no rotating or moving part so transformer is a static device. Transformer operates on ac supply. Transformer works on the principle of mutual induction. If we want to know the history of transformer we have go back long in the 1880s. Around 50 years before that in 1830 property of induction which is the working principle of transformer was discovered. Later the transformer design was improved resulting in more efficiency and lesser size. Gradually the large capacity of transformers in the range of several KVA, MVA came into existence. In the year 1950, 400KV **electrical power transformer** was introduced in high voltage electrical power system. In the early 1970s, unit rating as large as 1100 MVA was produced and 800KV and even higher KV class transformers were manufactured in year of 1980.

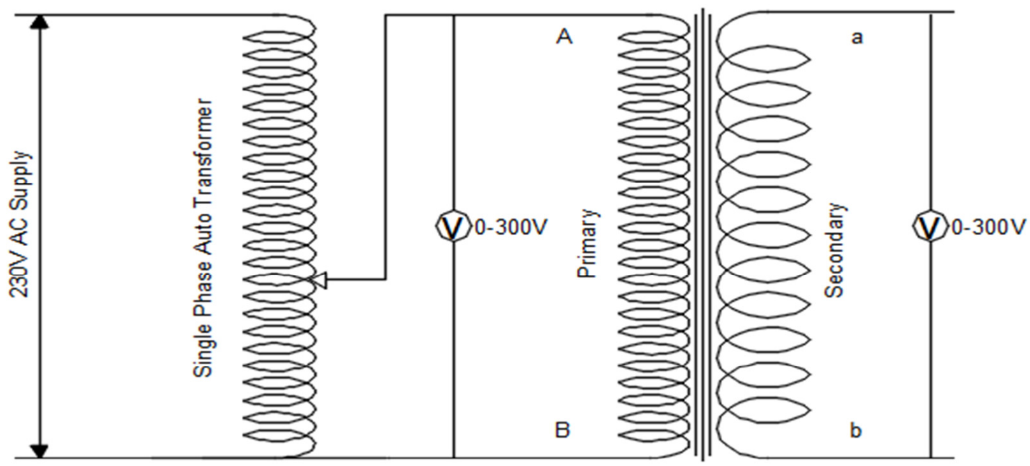
As the transformer is basically a linear device, a ratio now exists between the number of turns of the primary coil divided by the number of turns of the secondary coil. This ratio, called the ratio of transformation, more commonly known as a transformers "turns ratio", (TR). This turns ratio value dictates the operation of the transformer and the corresponding voltage available on the secondary winding. Transformers are all about "ratios". The ratio of the primary to the secondary, the ratio of the input to the output, and the turns ratio of any given transformer will be the same as its voltage ratio. In other words for a transformer: "turns ratio = voltage ratio". The actual number of turns of wire on any winding is generally not important, just the turns ratio and this relationship is given as:

$$\frac{\textit{number of turns on primary}}{\textit{number of turns on secondary}} = \frac{N_P}{N_S} = \frac{V_P}{V_S} = n = \textit{Turn Ratio}$$

Observation Table:

Sl.No.	Supply Voltage(V)	Secondary Voltage(V)	$K=V_1/V_2$
1			
2			
3			

Circuit Diagram:



Mesurement of turns Ratio of a single Phase Transformer

Procedure:

1. Connect the circuit as given in circuit diagram.
2. Get your circuit checked by instructer
3. Vary the input voltage by varying supply from autotransformer.
4. Take 5 set of readings.
5. Calculate the turn ratio.

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Experiment 9: To obtain the relationship between line and phase quantity in 3-Phase star connection and draw the phasor diagram.

Description: There are two types of system available in electric circuit, single phase and **three phase system**. In single phase circuit, there will be only one phase, i.e the current will flow through only one wire and there will be one return path called neutral line to complete the circuit. So in single phase minimum amount of power can be transported. Here the generating station and load station will also be single phase. This is an old system using from previous time. In 1882, new invention has been done on polyphase system, that more than one phase can be used for generating, transmitting and for load system. **Three phase circuit** is the polyphase system where three phases are send together from the generator to the load. Each phase are having a phase difference of 120°, i.e 120° angle electrically. So from the total of 360°, three phases are equally divided into 120° each. The power in **three phase system** is continuous as all the three phases are involved in generating the total power. In three phase circuit, connections can be given in two types:

1. Star connection
2. Delta connection

In star connection, there is four wire, three wires are phase wire and fourth is neutral which is taken from the star point. Star connection is preferred for long distance power transmission because it is having the neutral point. In this we need to come to the concept of balanced and unbalanced current in power system. When equal current will flow through all the three phases, then it is called as balanced current. And when the current will not be equal in any of the phase, then it is unbalanced current. In this case, during balanced condition there will be no current flowing through the neutral line and hence there is no use of the neutral terminal. But when there will be unbalanced current flowing in the three phase circuit, neutral is having a vital role. It will take the unbalanced current through to the ground and protect the transformer. Unbalanced current affects transformer and it may also cause damage to the transformer and for this star connection is preferred for long distance transmission.

Formula used

In a balanced 3-Phase Star connection the phase voltages in three loads are same in magnitude but they differ in phase from one another by 120^0.

V_R= Vsin(ωt)

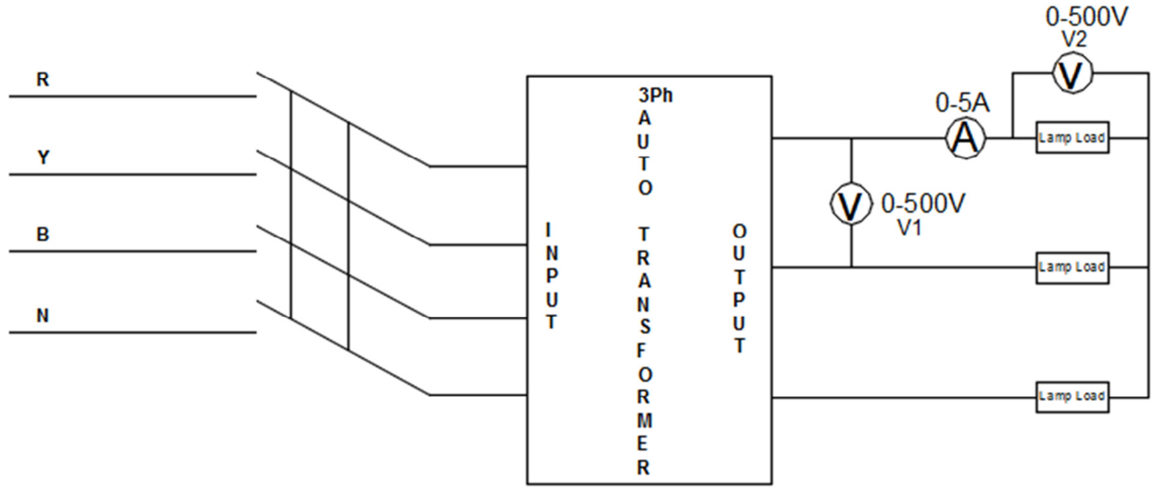
V_Y= $V\sin(\omega t-120^0)$

V_B = $V\sin(\omega t+120^0)$

When identical loads are connected in Star to the 3-phase supply the line currents and phase currents are same but the line voltages are given by, $I_P = I_L$

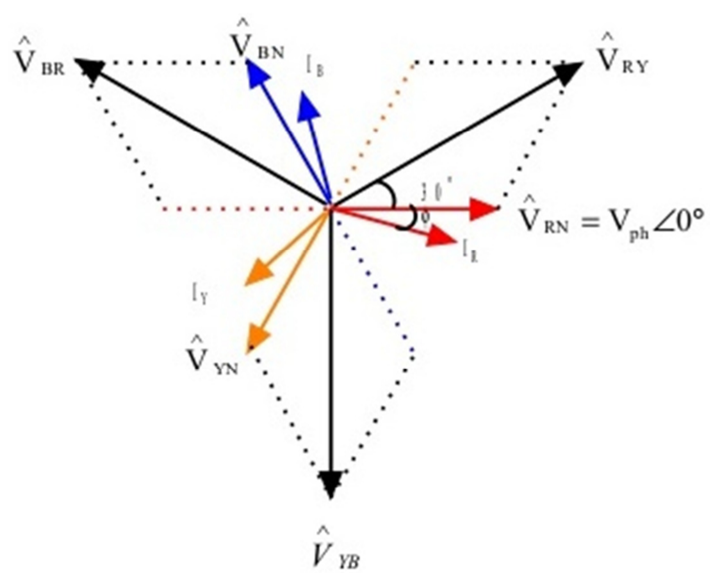
$V_{RY} = \sqrt{3}\ I \sin(\omega t - 30^0)$
$V_{YB} = \sqrt{3}\ I \sin(\omega t - 30^0 - 120^0)$
$V_{BR} = \sqrt{3}\ I \sin(\omega t - 30^0 + 120^0)$
Thus, we have, $V_P = (V_L)/\sqrt{3}$

Circuit diagram



Verification of Phase and Line Quantities in Star Circuit

PHASOR DIAGRAM:-



PROCEDURE:-

1. The connection is done according to the circuit diagram.
2. Initially, the points R, Y, B and N are joined to points A_1, B_1, C_1 and N respectively.
3. Then, the common terminal of the (0-500 V) voltmeter is connected to point a_1 and the common terminal of the ammeter.
4. Now, two wires are drawn from other terminal of the (0-500 V) voltmeter. One is joined to the point b_1 and other to the point S_2.
5. The point c_1 is connected to S_3 and the points F_1, F_2 and F_3 are connected to each other.
6. Now, two wires are drawn from S_1. One is connected to other terminal of ammeter and to (0-600 V) voltmeter.
7. Finally, the points F_1 and common terminal of (0-600 V) voltmeter are connected. This completes our circuit.

OBSERVATION TABLE :-

S.N.	I(Line) (A)	V(Phase) (A)	V(Line) (V)	V(Line)/ V(Phase)
1.				
2.				
3.				
4.				
5.				

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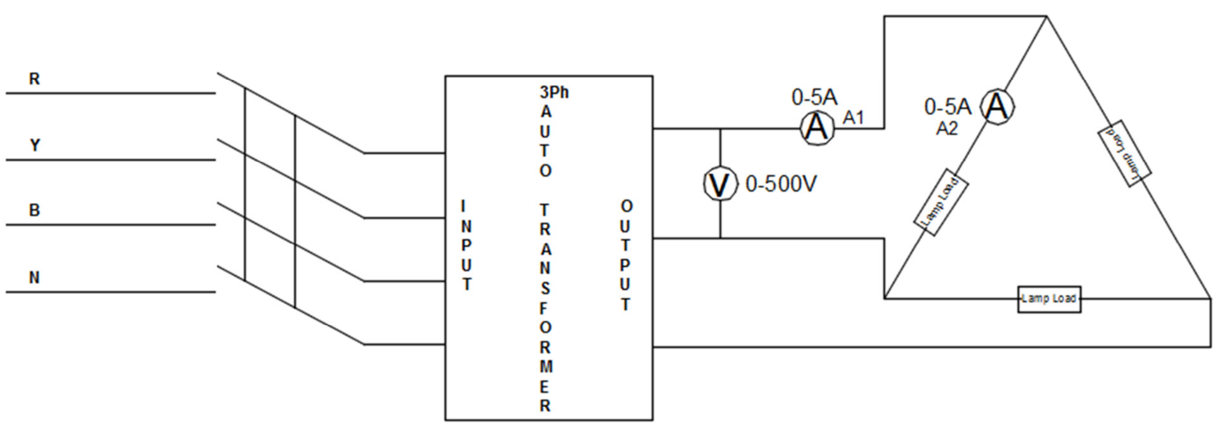
Experiment 9: To Verify I_L(Line Current) is $\sqrt{3}$ times I_P (Phase Current) in three phase Delta connection.

Description: There are two types of system available in electric circuit, single phase and **three phase system**. In single phase circuit, there will be only one phase, i.e the current will flow through only one wire and there will be one return path called neutral line to complete the circuit. So in single phase minimum amount of power can be transported. Here the generating station and load station will also be single phase. This is an old system using from previous time. In 1882, new invention has been done on polyphase system, that more than one phase can be used for generating, transmitting and for load system. **Three phase circuit** is the polyphase system where three phases are send together from the generator to the load. Each phase are having a phase difference of 120°, i.e 120° angle electrically. So from the total of 360°, three phases are equally divided into 120° each. The power in **three phase system** is continuous as all the three phases are involved in generating the total power. In three phase circuit, connections can be given in two types:

1. Star connection
2. Delta connection

In delta connection, there is three wires alone and no neutral terminal is taken. Normally delta connection is preferred for short distance due to the problem of unbalanced current in the circuit. In the load station, ground can be used as neutral path if required.

Circuit Diagram



Verification of Phase and Line Quantities in Delta Circuit

Formula Used

In a balanced 3-Phase Delta connection the phase currents in three loads are same in magnitude but they differ in phase from one another by 120^0.

I_{RY}= I sin(ωt)

I_{VB}= I sin(ωt-120^0)

I_{BR} = I sin(ωt+120^0)

When identical loads are connected in Delta to the 3-Phase supply the line voltage and phase voltage are same but the line current aregiven by,

$V_P = V_L$

$I_R = \sqrt{3}$ I sin(ωt-30^0)

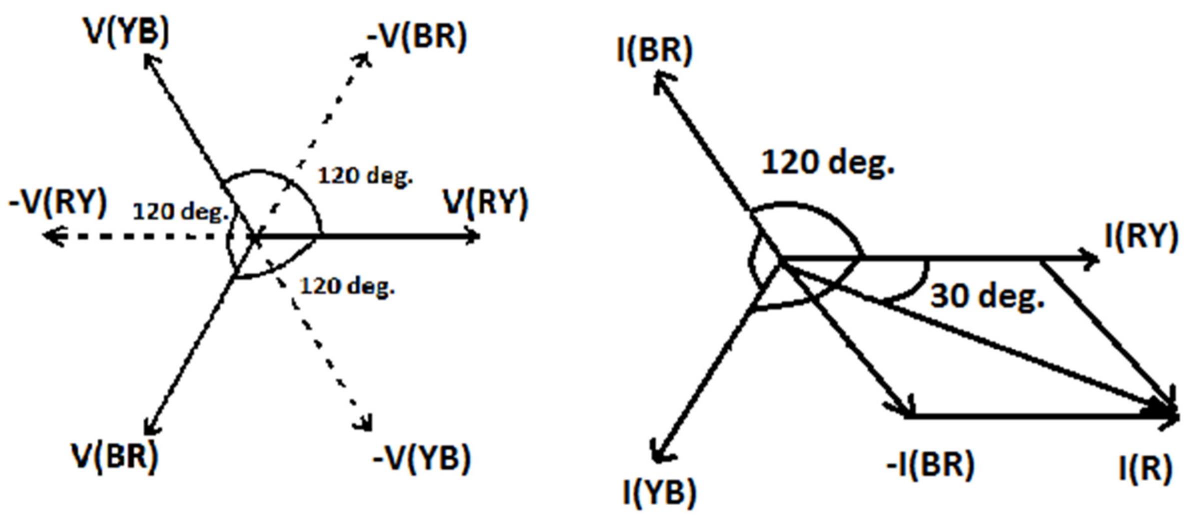
$I_Y = \sqrt{3}$ I sin(ωt-30^0-120^0)

$I_B = \sqrt{3}$ I sin(ωt-30^0+120^0)

Thus, we have

$I_P = (I_L)/\sqrt{3}$

PHASOR DIAGRAM:-



PROCEDURE:-

1. Initially, the point R marked on the panel was connected with A_1 , point Y with B_1 and point B with C_1 , respectively using connecting wires.
2. Two wires were drawn from a_1, one was connected with one of the knob of ammeter used for the measurement of the line current and other to the common knob of the voltmeter used for the measurement of the line voltage.
3. The other knob of this ammeter was joined to the point S_1 marked on the panel. One of the other knobs of the above used voltmeter marked 600V was connected to the point b_1 marked on the panel using connecting wires.
4. One knob of the ammeter used for the measurement of the phase current was connected to S_1 and other to F_1 using wires. S_2 is connected to b_1.
5. F_2 is connected with $S_2$and S_3 is connected to C_1 with wires. Similarly S_1 is connected to F_3 with a wire.
6. Power supply was switched ON.

7. The circular knob present on the Auto Transformer was slightly moved from its rest position and the corresponding values of I_L, I_P and $V_L$were recorded using respective instruments.

OBSERVATION TABLE:-

S.N.	I(Line) (A)	I(Phase) (A)	V(Line) (V)	I(Line)/ I(Phase)
1.				
2.				
3.				
4.				
5.				