PRACTICAL WORK BOOK
For The Course
EE-113 Basic Electrical Engineering

For

First Year

(Electrical & Electronics Engineering)

Name of Student: ______________________________

Class: ______________________ Batch :______________

Discipline: ______________________________

Class Roll No.: ____________ Examination Seat No.____________

Complied by: Engr. Syed Nadeem Haider (Lab. Engineer)

Supervised by: Engr. Irshad Ahmed Ansari (Asst. Prof.)

ELECTRICAL GENERAL PURPOSE LAB

DEPARTMENT OF ELECTRICAL ENGINEERING

NED University of Engineering & Technology, Karachi-75270, Pakistan

PRACTICAL WORK BOOK
For The Course
EE-117 Fundamentals of Electrical Engineering

For

First Year

(Telecommunication & C&IS Engineering)

Name of Student: ____

Class: ______________________________Batch :___________________

Discipline: ____

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NED University of Engineering & Technology, Karachi-75270, Pakistan

PRACTICAL WORK BOOK
For The Course
EE-115 Electrical Technology Fundamentals

For

First Year

(Bachelor of Computer & Information Technology)

Name of Student: ____

Class: ________________________________Batch :____________________

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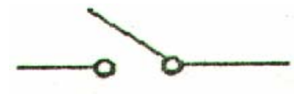
INDEX

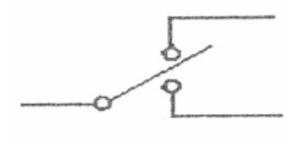
Experiment # 1

Subject: To study the various "Electrical Symbols".

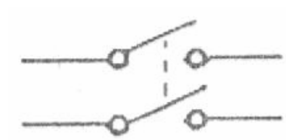
Single-pole Single-throw
(SPST) Switch



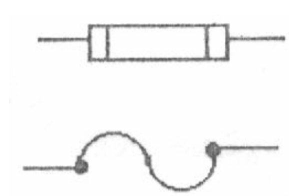
Single Pole Double-throw **(SPDT) Switch**



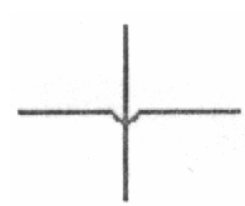
Double-pole, Single Throw (DPST) Switch



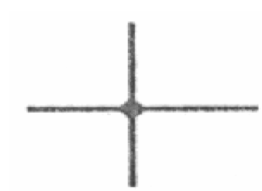
Fuse

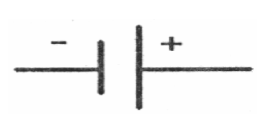


Two Conductors Crossing
(No Connection)



Two Conductors Connected

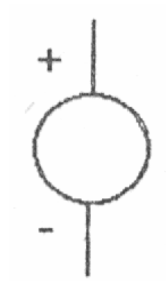




Cell

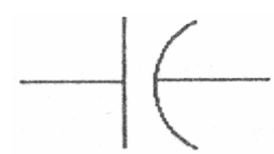
Battery

Power Supply
(Usually identified by voltage & type)
Polarity would indicate DC
Power Supply-Voltage Source



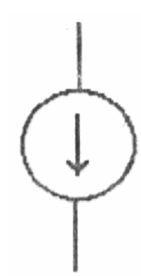
AC Power Supply-Voltage Source

Capacitor



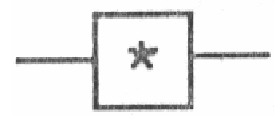
Inductor

Constant Current source



Meter

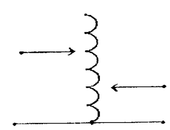
The letter in the center identifies the type
V = Voltmeter, A = Ammeter
Ω = Ohmmeter, MA = Milliammeter
W = Wattmeter, G = Galvanometer



Resistor or Resistance (Fixed value)

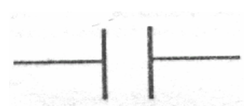
Transformer

Variable Voltage Transformer
(Autotransformer / Variac **Iron Core**

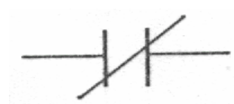


Relay Contacts

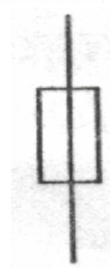
Normally Open (NO)



Normally Closed (NC



Relay (Energizing) Coil



Result:

EXPERIMENT # 2

Object: To verify experimentally that the Inductance of a series R-L circuit is given by the formula $Z = \sqrt{R^2 + X_L^2}$. Also find out power and power factor of the circuit.

Apparatus:

•Resistor	One
•Inductor (choke) 2.2 H	One
•Variac (Variable Transformer) 0 – 260 V A. C.	One
•Ammeter	One
•Voltmeter	Two

Theory:

A.C:

A.C. means alternating current - the current or voltage that alternates its direction and magnitude every time.

Inductance:

It is a property of the coil due to which it opposes any increase or decrease of current or flux through it is known as INDUCTANCE. It is measured in Henry and denoted by L.

Inductive Reactance:

The effective opposition offered to current by inductance is called is called inductive reactance. It is denoted by X_L and is equal to $2\pi fL$.

Impedance

Total opposition offered by a series ac circuit containing resistance, inductance and capacitance is called impedance. In R-L circuit voltage is dropped across coil (ahead of I by 90^o).

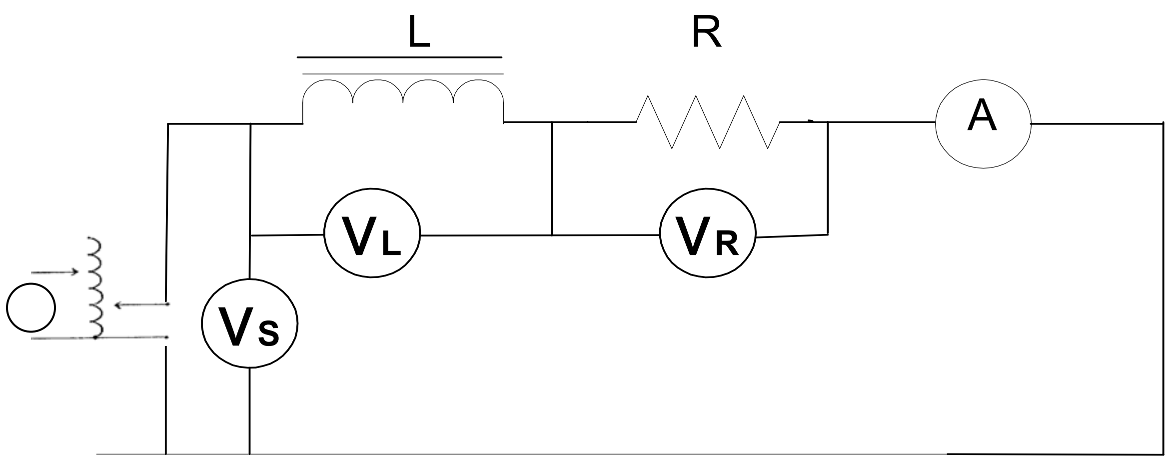
Formulae:

i. $\tan \phi = V_L/V_R$ Or $\phi = \tan^{-1} V_L/V_R$

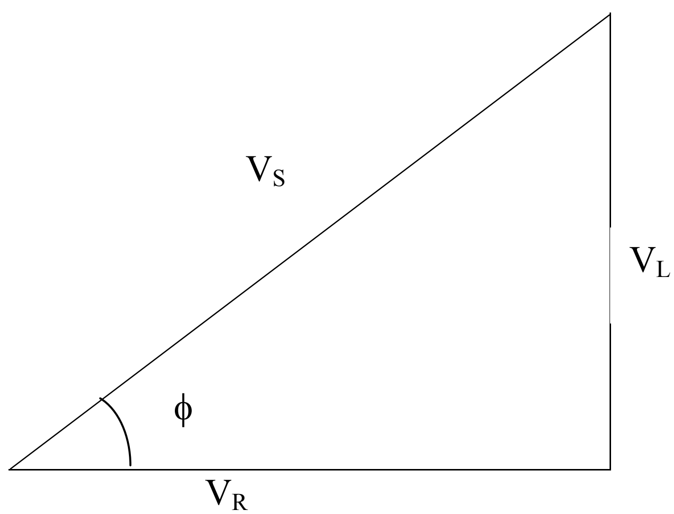
ii. Power Factor = $\cos \phi$

iii. Power $= V_S I_S \cos \phi$

iv. Impedance $= Z = \sqrt{(R^2 + X_L^2)}$



Phasor Diagram:



Observations:

Least Count of milliammeter = 20 mA

Least Count of Voltmeter = 5V

Least Count of Variac (Variable Voltage Transformer) = 10V

S. No.	V_S	V_L	V_R	$I_{S\ (ma)}$	$I_{R\ (ma)}$
1					
2					
3					
4					
5					
6					

Calculations:

- $X_L = 2\pi fL$ Where L = 2.2 Henry; f = 50 Hertz

- $R = V_R/I_R$

  $R_1 =$

  $R_2 =$

  $R_3 =$

Result:

Precautions:

EXPERIMENT No. 3

Object: To verify experimentally that the impedance of a series R-C circuit is given by the formula $Z = \sqrt{R^2 + X_C^2}$. Also find out power and power factor of the circuit.

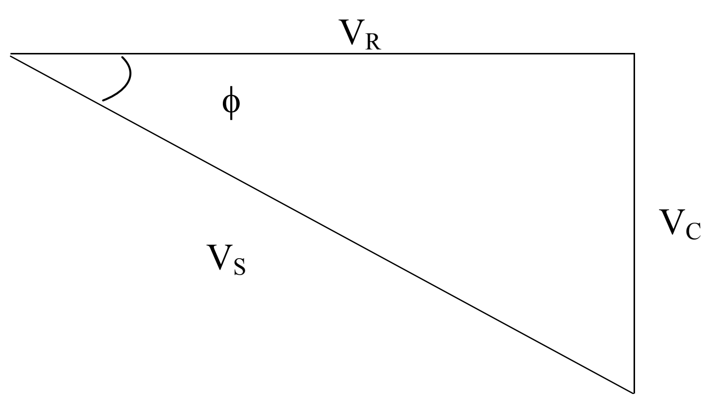
Apparatus:

•Resistor (Electric Lamp)	One
•Capacitor Variable	One
•Ammeter	One
•Voltmeter	One

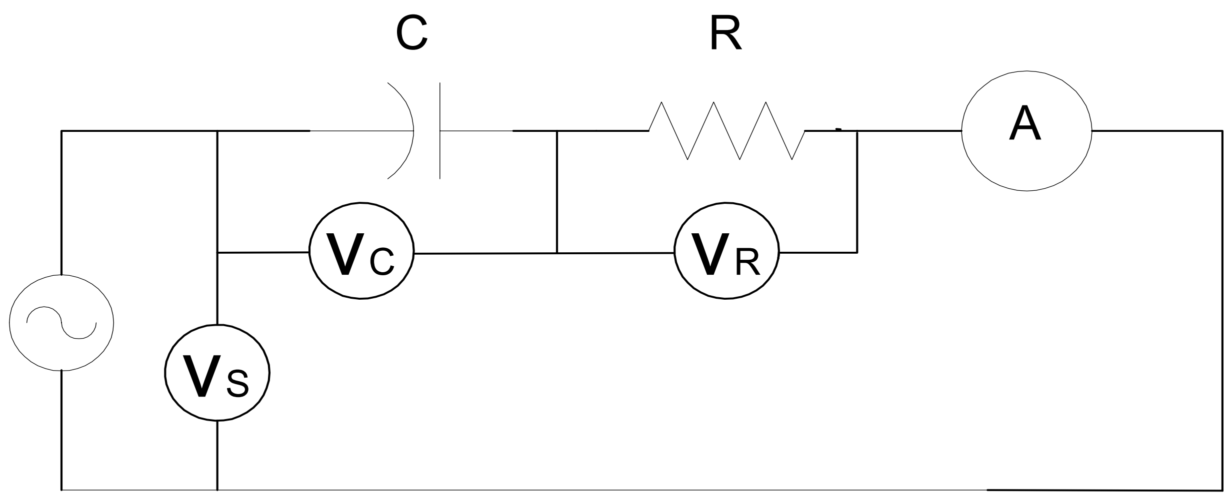
THEORY:

Capacitive reactance:
The effective opposition offered to current by capacitance is called Capacitive Reactance. It is measured in Ohms and is denoted by X_C where C is the capacitance and $X_C = 1/2\pi fC$
In R-C circuit voltage drop across the capacitor lags the current by 90°.

Capacitance: The property of a capacitor to store charges or electricity is called capacitance
Impedance: Total opposition offered by a series ac circuit containing resistance, inductance and capacitance is called impedance. Z denotes it



Phasor Diagram



Circuit Diagram

Formulae:

i. $\tan\phi = V_c/V_R$

or

$\phi = \tan^{-1} V_c/V_R$

ii. Power Factor = $\cos\phi$

iii. $\cos\phi = V_S / V_R$

iv. Active Power $= V_S I_S \cos\phi$

v. Impedance $= Z = \sqrt{(R^2 + X_c^2)}$

Observations:

Least Count of milliammeter = 5 mA
Least Count of Voltmeter = 5V
Least Count of Variable Voltage Autotransformer = 10 V

S. No.	V_S (volt)	V_R (volt)	V_C (volt)	I_S (ma)	I_R (ma)
1					
2					
3					
4					
5					
6					

Calculations:

$C = 2.5 \times 10^{-6}$ F
$X_C = 1/ 2\pi fC$
$=$
$X_C =$ ____________

$Z = \sqrt{(R^2 + X_C^2)}$
$Z_1 =$

$Z_3 = \{($ ____________ $)^2 + ($ ___________ $)^2\}^{1/2}$

$=$ ______ Ω

Result:

Precautions:

EXPERIMENT NO. 4

Object: To study the steady state response of series RLC circuit with AC supply and to find impedance, power and power factor of the circuit.

Apparatus:

Inductor
Variable capacitor
Variable resistor
Variable
Voltage source (Variac)
Ammeter
Voltmeter etc.

Theory:

Let us consider a circuit in which resistance R inductance L and capacitance C are connected in series with an alternating voltage. We know that inductance and capacitance always oppose each other. The impedance of the circuit can, therefore, be determined by the vector addition of the net reactance and resistance and is given by

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

Where $X_L = 2\pi fL$

$X_C = 1/ 2\pi fC$

The current I_s *will, therefore, be*

$$I_s = \frac{Vs}{Z} = \frac{Vs}{\sqrt{R^2 + (X_L^2 - X_C^2)}}$$

The current and voltage are not in phase in a series RLC circuit. The current lags the voltage by an angle ϕ is given by

$$\text{Tan } \phi = \frac{V_L - V_C}{V_R} \qquad \phi = \text{Tan}^{-1} \left(\frac{V_L - V_C}{V_R} \right)$$

Observations:

S. #	V_S *(Volt)*	V_L (Volt)	V_C (Volt)	V_R (Volt)	I_S *(ma)*	I_R *(ma)*
01						
02						
03						
04						
05						
06						
07						
08						
09						
10						

Calculations:

Result:

Source of Error and Precautions

1) **Before applying the voltage to the elements of R, L and C the maximum ratios must be known.**

2) Before switching on the circuit, get it checked by the Instructor.

3) Switch must be closed only when readings are to be taken.

4) Use a digital multimeter for measuring voltage and current.

EXPERIMENT No. 5

Object: To Verify Ohm's Law Experimentally & to find the Relationship between Voltage, Current & Resistance in a Circuit.

Apparatus:

1. Voltmeter (0-30 volts) One
2. Ammeter (0-25 mA) One
3. D.C. Supply (Regulated 0-30 volts) One
4. Resistance box One

Theory: Ohm's law states that "$I \alpha V$ i.e. current is directly proportional to the voltage", as "the current increases the voltage drop also increases", keeping the resistance constant and that "Current is inversely proportional to the Resistance", as "the Resistance increases, the Current decreases provided That the Voltage remains constant".

Observations:

L. C. of voltmeter = 1 volt
L.C. of milliammeter = 0.2 mA.
Voltage verses current where R = 100 Ω

Resistance Constant 100 Ω ($V \alpha I$)

V (volts)	I(mA) Obsereved	I(mA) Calculated

Voltage Constant ($I \alpha 1/R$)

Resistance Ω	I(mA) Obsereved	I(mA) Calculated

Calculation:

$V = IR$

$I = V/R$

When R is constant

i.e. R = 100 Ohms

1) I =

2) I =

3) I =

4) I =

When Voltage is constant

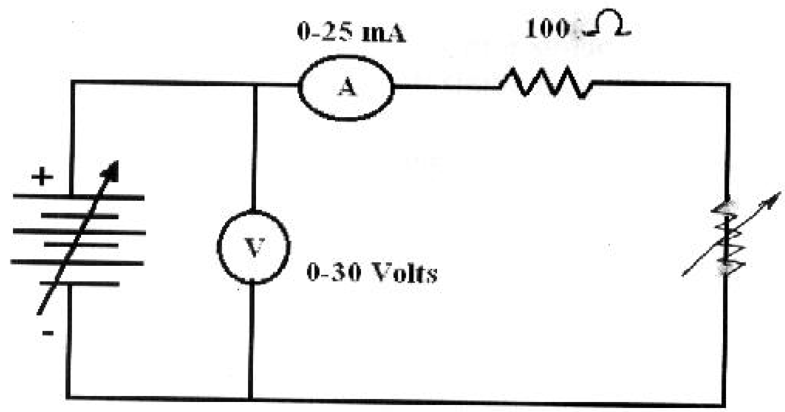
i.e V=25 volts

1)

2)

3)

4)



D.C. Regulated power supply.
0-30 Volts.

EXPERIMENT NO :- 06

Object:

a) To verify " Thevenin's Theorem " by finding its Thevenin's equivalent circuit 5V , 10V , 15V

b) Determine the load current for RL = 120Ω , 1KΩ , & 390Ω

Theory:

Any linear circuit is equivalent to a single voltage source (Thevenin's voltage) in a series with single equivalent resistance (Thevenin's equivalent resistor).

The current flowing through a load resistance RL connected across any two terminals a and b of a network is given

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

Where V_{TH} is open circuit voltage and R_{TH} is the internal resistance

Procedure:

1) Reduce the circuit by calculating the Thevenin equivalent resistance across the terminals "a" , "b"
2) Determine the Thevenin equivalent voltage across terminals "a" and "b" for 5V , 10V , 15V
3) Now, combine the Thevenin voltage with its resistance and determine currents across 120Ω , 1KΩ and 390Ω resistors.

OBSERVATION TABLE

Table 1

Voltage Vs	R1	R2	R3	Vth volts	Rth ohms
5V					
10V					
15V					

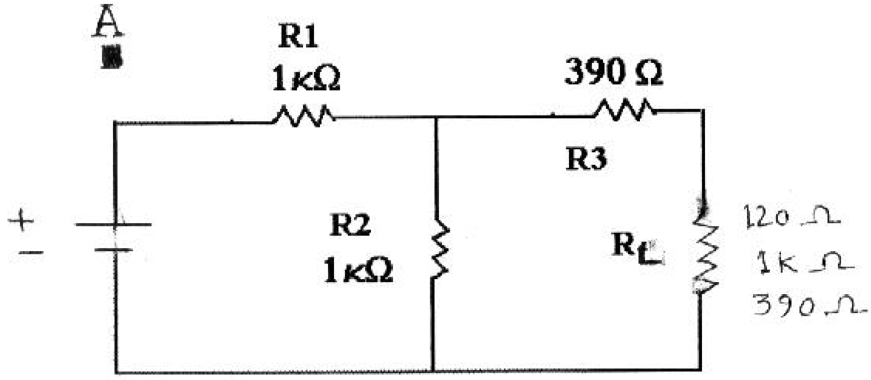
Table 2

Vth volts	Rth ohms	RL ohms	IL mA
		120	
		390	
		1K	
		120	
		390	
		1K	
		120	
		390	
		1K	

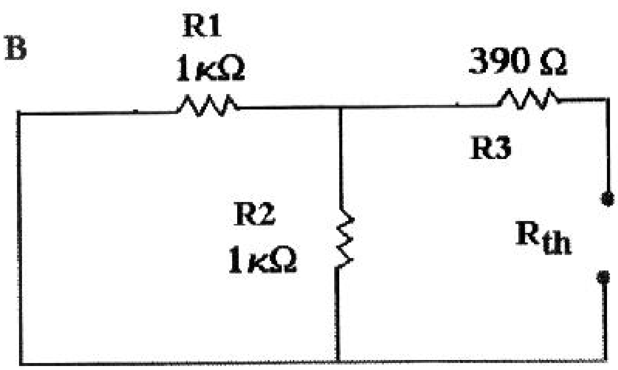
RESULT:

Thevenin equivalent circuitry played the same role as the whole complex circuitry across terminals "a" , "b" hence Thevenin's law is proved. The value of currents across 120Ω , 1KΩ , and 390Ω resistors were determined correctly.

A



B



C

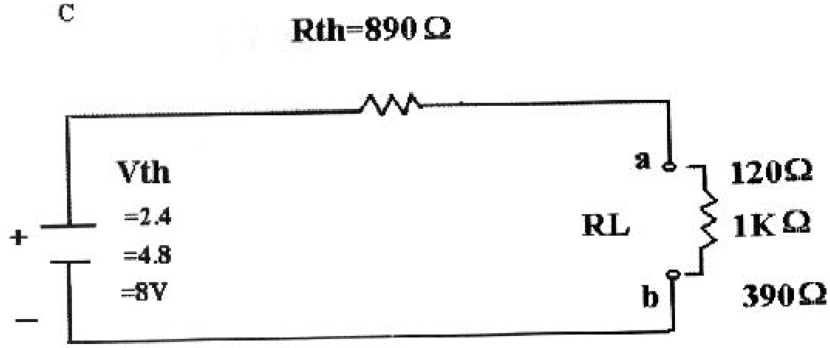


FIG A, B, C =VERIFICATION OF THEVENIN'S THEOREM BY THEVENIN'S EQUIVALENT CIRCUIT

EXPERIMENT NO. 7

Object: To analyze a two mesh circuit and to determine the current in each branch of the circuit.

Apparatus:

Circuit Kit
Avometer
Ammeter (milliammeter)
Power supply units.

Theory: **Algebraic sum of voltages around a close loop is zero.**

$$\Sigma\, IP + \Sigma\, E = 0$$

Applying KVL to mesh 1

$$-E_1 + (I_1 - I_2) R_2 + I_1 R_3 = 0$$

$$I_1 (R_2 + R_3) - I_2 R_2 = E_1 \text{ - - - - - - - - - - } \quad (1)$$

In mesh 2

$$-E_2 + (I_2 - I_1) R_2 + I_2 R_1 = 0$$

$$I_2 (R_1 + R_2) - I_1 R_2 = E_2 \text{ - - - - - - - - - - - - - } \quad (2)$$

$$\begin{bmatrix} R_2 + R_3 & -R_2 \\ -R_2 & R_1 + R_2 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} E_1 \\ E_2 \end{bmatrix}$$

Calculations:

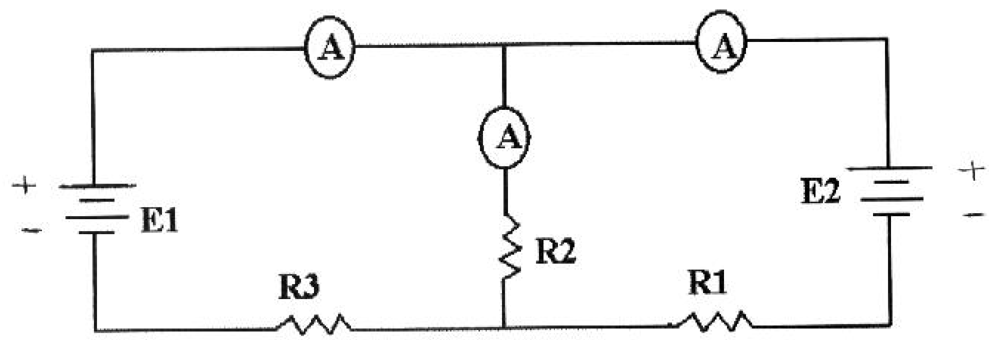
SOURCES OF ERRORS AND PRECAUTIONS

1) The connection must be tight and clean
2) Reading should be taken carefully
3) Circuit breaker must be connected in order to protect the circuit

RESULT

CIRCUIT DIAGRAM

CIRCUIT DIAGRAM



Experiment No:- 08

OBJECT:

To study the construction and basic principle of working of single phase induction motor

CONSTRUCTION

In A.C motors , the rotor does not receive electric power by construction but by induction , that is why such motors are called Induction motors

Single phase induction motor is extensively used for various kinds of industrial devices. It consists of two main parts .

1 STATOR
2 ROTOR

STATOR:

It is made up of a member of stampings which are sloted and receive the windings. The stator carries the single phase and is fed from single phase supply. It is wound for a definite number of poles. Greater the number of poles lesser the speed and vice versa. The stator winding when supplied by single phase current does not produces the magnetic flux. Now an alternating pulsating flux acting on station any rotor does not produces rotation. That is why single phase motor is not self starting

ROTOR:

The rotor consists of a cylindrical laminated ore with parallel slots for carrying the rotor conductor which it should be roted clearly are not wires but consists of heavy bars of copper aluminium or alloys. These bars are based on electrically welded or bolted to two heavy and short circuitly end rings. The rotor and slots are usually not quite parallel to the shaft but are purposely given a slight skew. This is useful in two ways

1 It helps to make the motor run by reducing magnetic
2 It helps in reducing locking tendency of the rotor.

WORKING:

Single phase induction motor is not self starting as discussed above. To overcome the draw back and to make the motor self started it is temporarily converted into two phase motor during started period for this purpose the stator of single phase motor is provided with an extra winding in addition to main and running winding .The two windings are placed 90deg electrically apart and are connected in parallel across the single phase supply.

It is so arranged that the phase difference between the current in two stator winding is very large (ideal value 90deg) , hence the motor behaves like a two phase motor these two currents produce the revolving flux and hence make the motor self starting

There are many methods by which the necessary phase difference between the two currents can be created.

1 Split phase machine
2 Capacitor start induction run motor

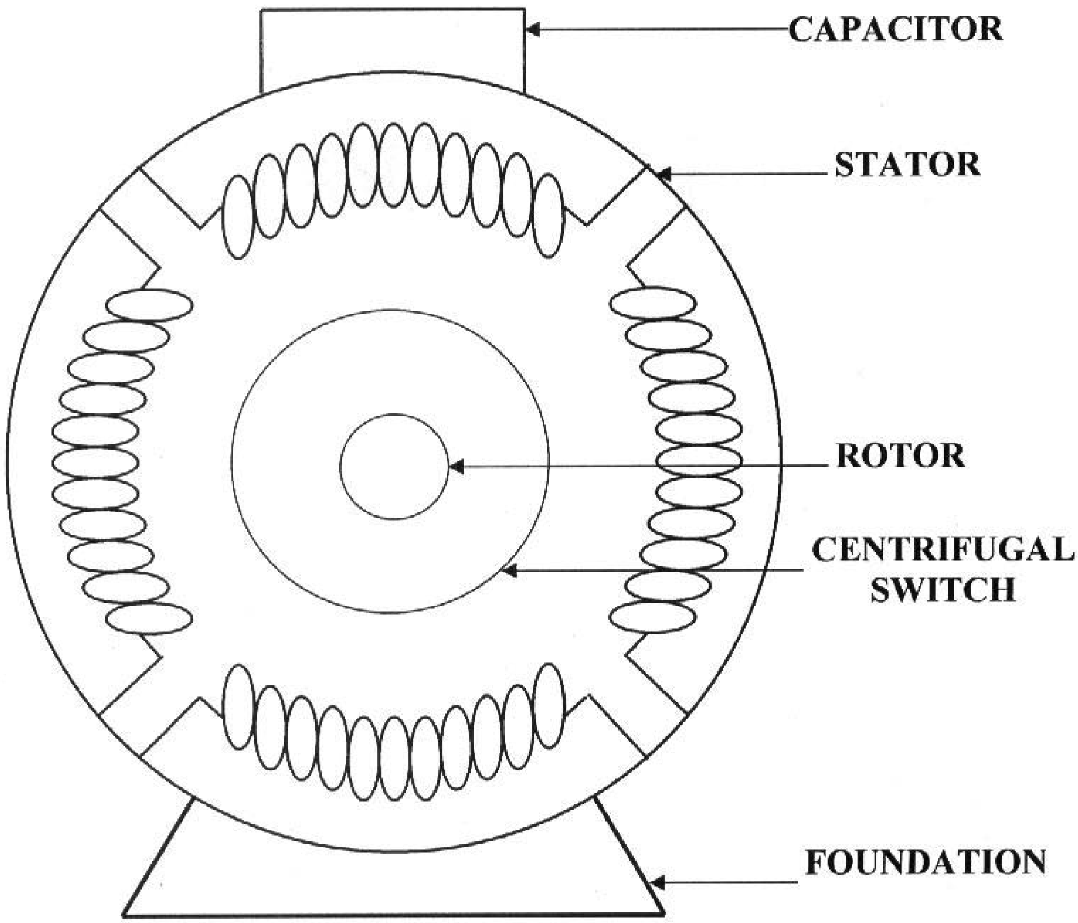
Here we discuss the capacitor start induction run motor

In these motors the necessary phase difference between Is and Im is produced by connecting a capacitor in series with the starting winding as in fig. The capacitor is generally of electrolytic type and is usually mounted on the outside of the motor as a separate unit.

The capacitor is designed for extremely short duty service and is guaranteed for not more than 20 periods of operating per hour, each period not to exceed 3 seconds. When the motor reaches about 75% of speed the centrifugal switch S opens and outs the starting winding and the capacitor from the supply thus leaking only the running winding across the lines.

As shown in fig, current Im drawn by main winding layers. The supply voltage v by a large angle whereas Is leeds v by certain angle. The two currents are out of phase with each others by about 80deg (for a 200w and 50hz motor) as compared to nearly 30deg for split phase motor. Their resultant current I is small and almost in phase with v as in fig.

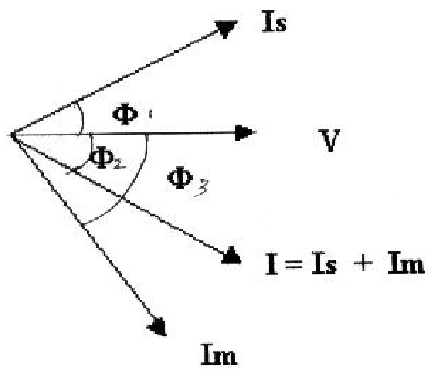
Since the torque developed by split phase motor is proportional to the sine of the angle between Is and Im it is obvious that the increase in the angle (from 30 to 80deg) alone increases the starting torque to nearly twice the value developed by a standard split phase induction motor. Other improvement in motor design have made it possible and increase the starting torque to a value as high as 350 to 450%



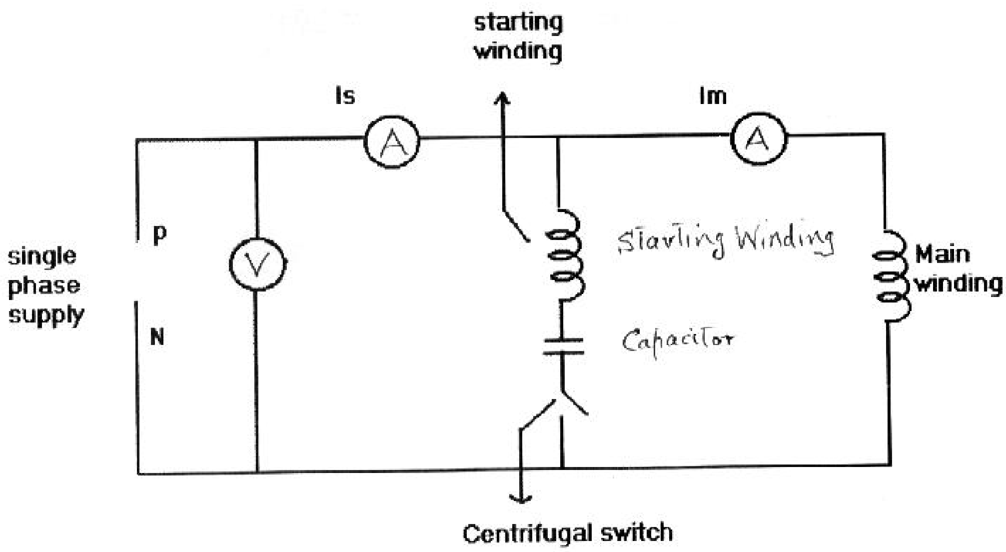
THE SINGLE PHASE
INDUCTION MOTOR

[redacted]
2 8 [redacted]

PHASOR DIAGRAM



CIRCUIT DIAGRAM



Experiment No:- 09

OBJECT:

To verify law of resistance connected in parallel circuit.

APPARATUS:

- Multimeter
- Ammeter
- D.C supply
- Resistances
- Wires

THEORY:

$$V_T = V_1 = V_2 = V_3$$

$$I_T = I_1 + I_2 + I_3$$

According to Ohms Law $I = \frac{V}{R}$

$$\frac{V_T}{R_T} = \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}$$

$$\frac{V_T}{R_T} = V_T \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right)$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

In a parallel circuit voltage across all the resistors remains same and the supply current or total current is the sum of the individual currents in different parallel paths. The sum of the reciprocal of parallel resistances connected in the circuit is equal to the reciprocal of equivalent resistance connected in the circuit.

OBSERVATION:

V_T Remains constant throughout the experiment

$V_T = V_1 = V_2 = V_3 =$

I_T	I_1	I_2	I_3	R_T	R_1	R_2	R_3

CALCULATION:

$$V_T = V_1 = V_2 = V_3$$

---- = ----- = ----- = -----

$$I_T = I_1 + I_2 + I_3$$

I_T = ---- + ---- + ----

I_T = -------

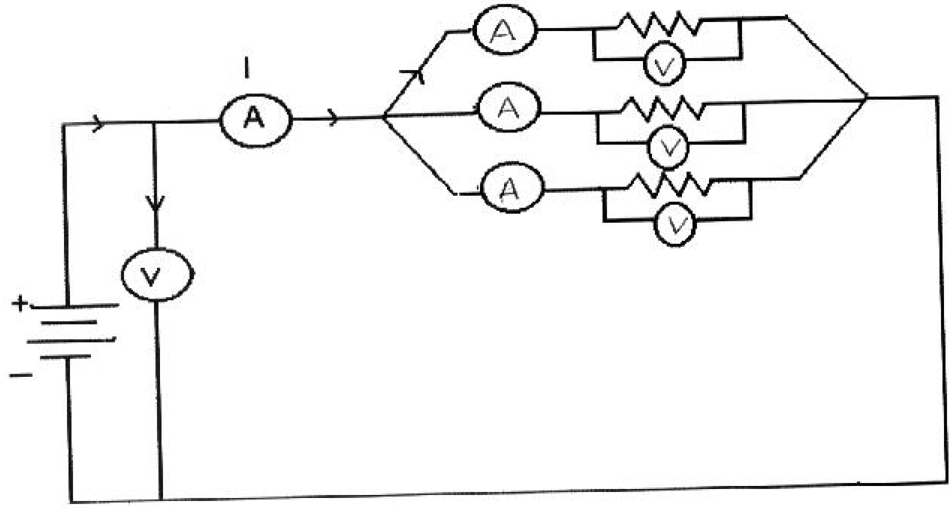
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

-------- = ------ + ------- + --------

FEATURES OF PARALLEL CIRCUIT

1) Same voltage acts across all parts of the circuit
2) Different resistors or branches have their individual currents
3) Total circuit currents is equal to the sum of individual currents through the various resistors or branches
4) Branch currents are additive
5) The reciprocal of the equivalent or combined resistance is equal to the sum of their reciprocals of the resistances of the individual branches

CIRCUIT DIAGRAM



Experiment No:- 10

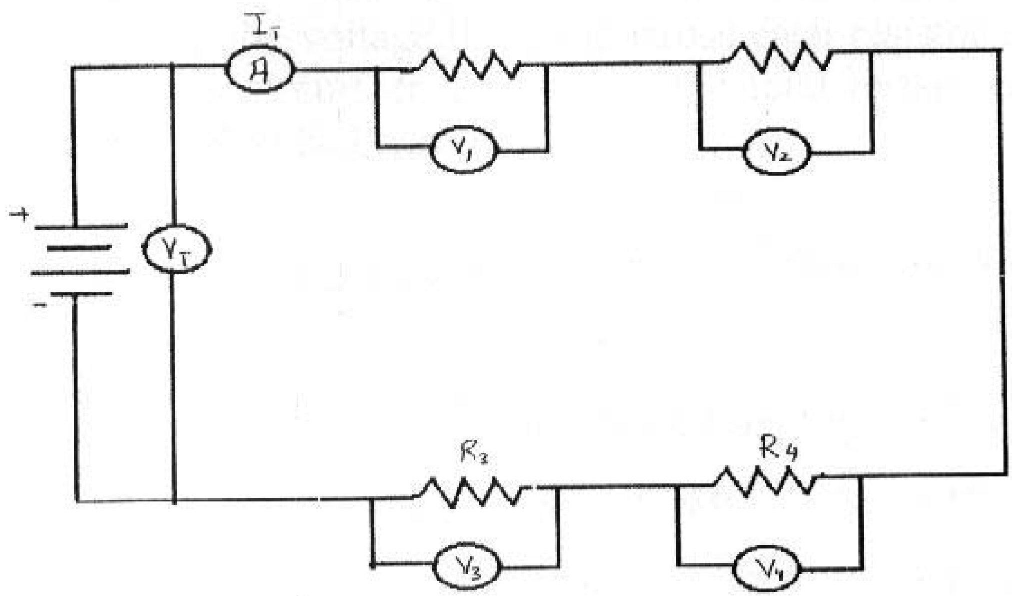
OBJECT:

To verify law of resistance connected in series circuit.

APPARATUS:

- Multimeter
- Ammeter
- D.C supply
- Resistances
- Wires

CIRCUIT DIAGRAM



THEORY:

The circuit in which the current remains same and the voltage different across each resistor is called the Series circuit. In this circuit the total resistance is the sum of individual resistors.

$$V_T = V_1 + V_2 + V_3 + V_4$$

According to Ohms Law $V = IR$

$$I R_T = IR_1 + IR_2 + IR_3 + IR_4$$

$$I R_T = I(R_1 + R_2 + R_3 + R_4)$$

$$R_T = R_1 + R_2 + R_3 + R_4$$

There are four resistance and they are connected in series.

R_T = Total resistance
V_T = Total voltage
I_T = Total current

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I_T = Total current

OBSERVATIONS:

I_T Remains constant throughout the experiment

$I_T = I_1 = I_2 = I_3 = I_4 =$

V_T	V_1	V_2	V_3	V_4	R_T	R_1	R_2	R_3	R_4

CALCULATION:

$I_T = I_1 = I_2 = I_3 = I_4$

------ = ----- = ------ = ------ = -------

$V_T = V_1 + V_2 + V_3 + V_4$

V_T = ------ + ------- + ------ + --------

V_T = -------

$R_T = R_1 + R_2 + R_3 + R_4$

----- = ---- + ---- + ---- + ----