BEE Lab Assignment Exp-9

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BTECH 10072/20
Section E
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Course Outcome and Objective :

Course Objectives

This course enables the students :

A.	To describe students practical knowledge of active and passive elements and operation of measuring instruments
B.	To demonstrate electrical circuit fundamentals and their equivalent circuit models for both 1-φ and 3- φ circuits and use circuit theorems
C.	To establish voltage & current relationships with the help of phasors and correlate them to experimental results
D.	1. To conclude performance of 1 – Φ AC series circuits by resonance phenomena 2. To evaluate different power measurement for both 1-φ and 3- φ circuits

Course Outcomes

After the completion of this course, students will be able to:

1.	classify active and passive elements, explain working and use of electrical components, different types of measuring instruments;
2.	illustrate fundamentals of operation of DC circuits, 1-φ and 3- φ circuits and also correlate the principles of DC, AC 1-φ and 3- φ circuits to rotating machines like Induction motor and D.C machine.;
3.	measure voltage, current, power, for DC and AC circuits and also represent them in phasor notations;
4.	analyse response of a circuit and calculate unknown circuit parameters;
5.	recommend and justify power factor improvement method in order to save electrical energy.

Basics of Electrical Engineering LAB-

EXPERIMENT	DATE	Course Outcome	Column
1. Familiarity with basic circuit elements and measuring	3rd August 2021	Understood the basic idea and working of simple circuit elements like Ammeter, Voltmeter etc.	
2. Verification of Thevenin and Norton theorem	7th August 2021	Gained the knowledge to solve problem of electrical circuit using thevenin and Norton's theorem	
3. Verification of Superposition Theorem	8th August 2021	Gained the knowledge to solve electrical circuits using Superposition Theorem	
4.Verification of Maximum Power Transfer Theorem	17th August 2021	Gained the knowledge to solve problem of electrical circuit using Maximum Power transfer theorem.	
5. To determine the High Resistance by the Megohm Bridge method. To study the Kelvin Double Bridge for Low resistance measurement	24th August 2021	Was able to determine High Resistance by using the Megohm Bridge method and was able to determine Low Resistance by using the Kelvin Double Bridge method.	

EXPERIMENT	DATE	Course Outcome	Column
6. Measurement of self-inductance by Maxwell's Bridge. Measurement of Capacitance by Wein Series Bridge	31st August 2021	would be able to calculate Self-Inductance using Maxwell's Bridge was able to calculate Capacitance using Wein Series Bridge.	
7. To study the behaviour of a series RLC circuit.	12th September 2021	was able to study and understand the behavioural working of a series R-L-C circuit.	
8. Three phase power measurement using two wattmeter method.	14th September 2021	was able to study Three phase power measurement using two wattmeter method	
9. To determine the Efficiency and Regulation of a single phase Transformer by conducting (a) open circuit test and (b) short circuit test.	21st September 2021	was able to determine the Efficiency and Regulation of a single phase Transformer by conducting (a) open circuit test and (b) short circuit test.	

Experiment - 9

Measurement of efficiency and regulation of Single Phase Transformer.

- ***Aim -*** To determine the Efficiency and Regulation of a single phase Transformer by conducting (a) open circuit test and (b) short circuit test.

Theory –

The physical basis of the transformer is mutual induction between two circuits linked by a common magnetic field. Transformer is required to pass electrical energy from one circuit to another, via the medium of the pulsating magnetic field, as efficiently and economically as possible. This could be achieved using either iron or steel which serves as a good permeable path for the mutual magnetic flux.

Elementary Transformer:

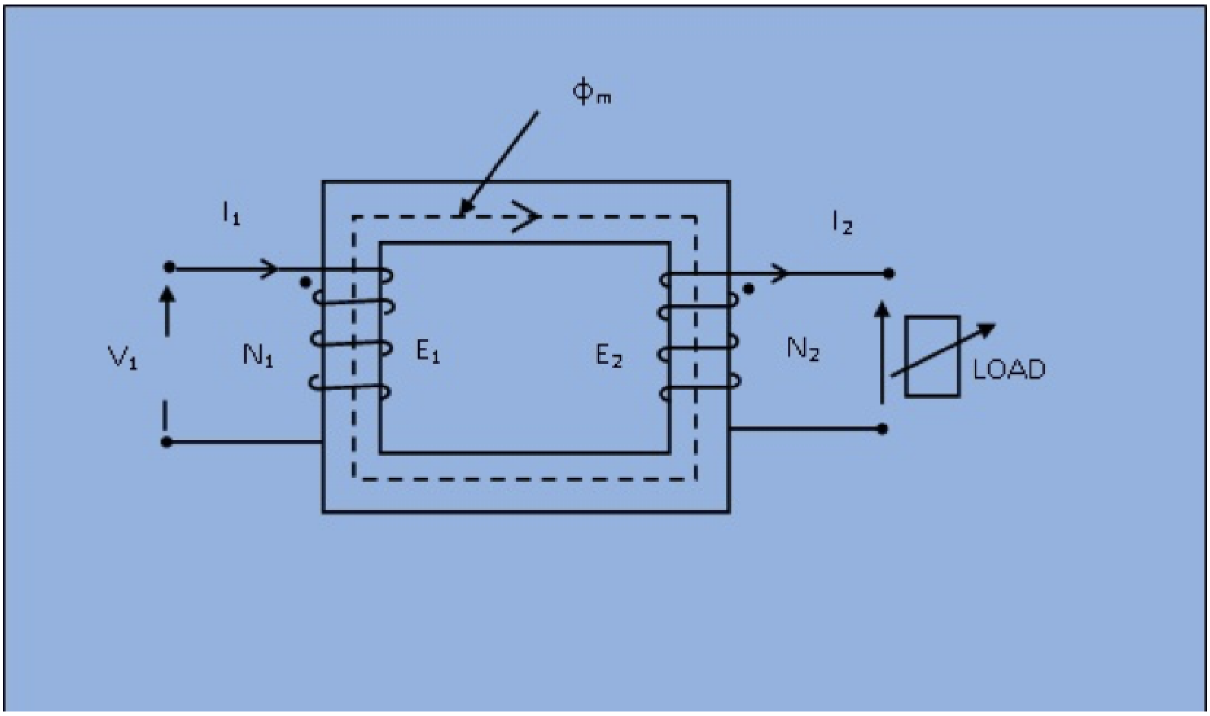


Figure 1 :

Let an alternating voltage V1 be applied to primary coil of N1 turns linking a suitable iron core. A current flows in the coil , establishing a flux ϕ in the core. This flux induces an emf e1in the coil to counter balance the applied voltage V1. This emf is

$e1=N1d\phi p/dt$

Assuming sinusoidal time variation of the flux, let $\phi p = \phi m\sin(\omega t)$. Then,

$e1=N1\omega\phi m\cos(\omega t)$, where $\omega=2\pi f$

The r.m.s value of this voltage is given by :

$E1=4.44fN1\phi m$

78

Now if there is a secondary coil of N2 turns, wound on the same core, then by mutual induction an emf e2 is developed therein. The r.m.s value of this voltage is given by:

$E2=4.44fN2\phi'm$

Where $\phi'm$ is the maximum value of the (sinusoidal) flux linking the secondary coil(ϕs).

If it is assumed that $\phi p=\phi s$ then the primary and secondary emf bear the following ratio:

$e1/e2=E1/E2=N1/N2$

Note that in actual practice, $\phi p=\phi s$ since some of the flux paths linking the primary coil do not link the secondary coil and similarly some of the flux paths linking the secondary coil do not link the primary coil. The fluxes which do not link both the coils are called "Leakage Fluxes" of the primary and secondary coil.

Although the iron core is highly permeable, it is not possible to generate a magnetic field in it without the application of a small m.m.f (magneto motive force, denoted by mmf.

$Ph=KhBxmaxf$ $Pe=KeB2maxf2$ and $Pc=Ph+Pe$

where Ph,Pe,Pc are hysteresis, eddy current and core losses respectively, Kh and Ke are constants which depend upon on the magnetic material, and Bmax is the maximum flux density in the core.

Equivalent Circuit of a Practical Transformer:

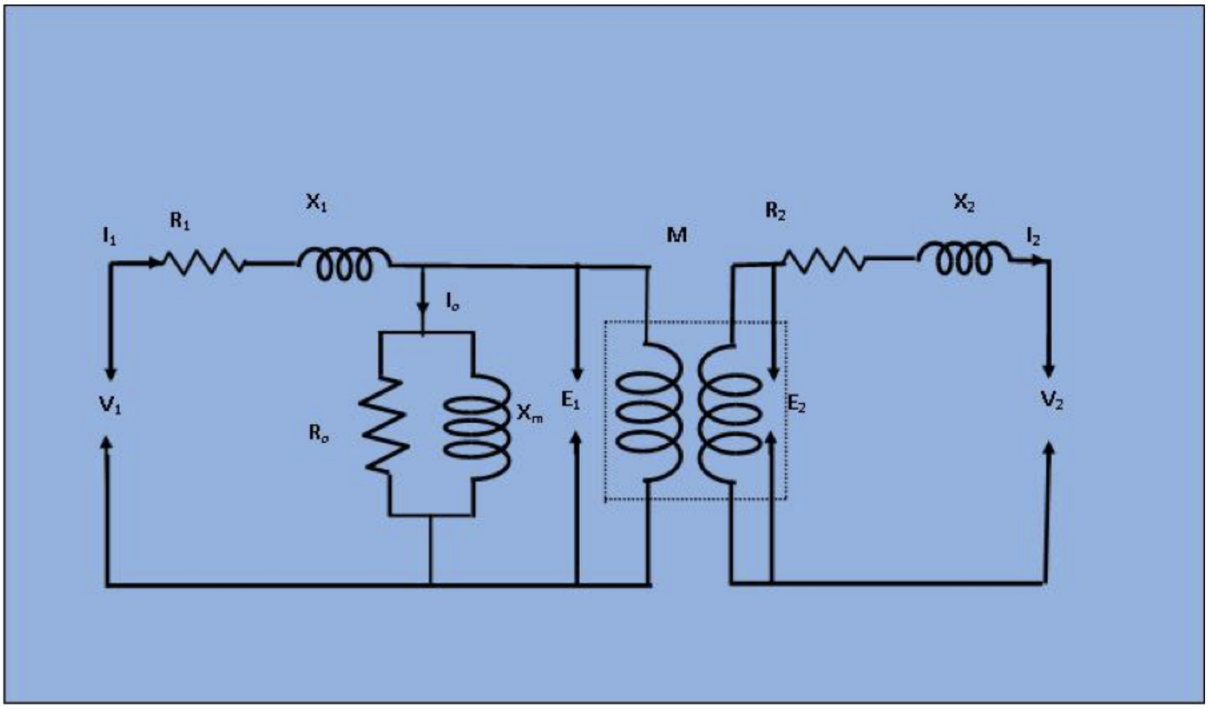


Figure 2(A)

Development of Transformer Equivalent Circuit:

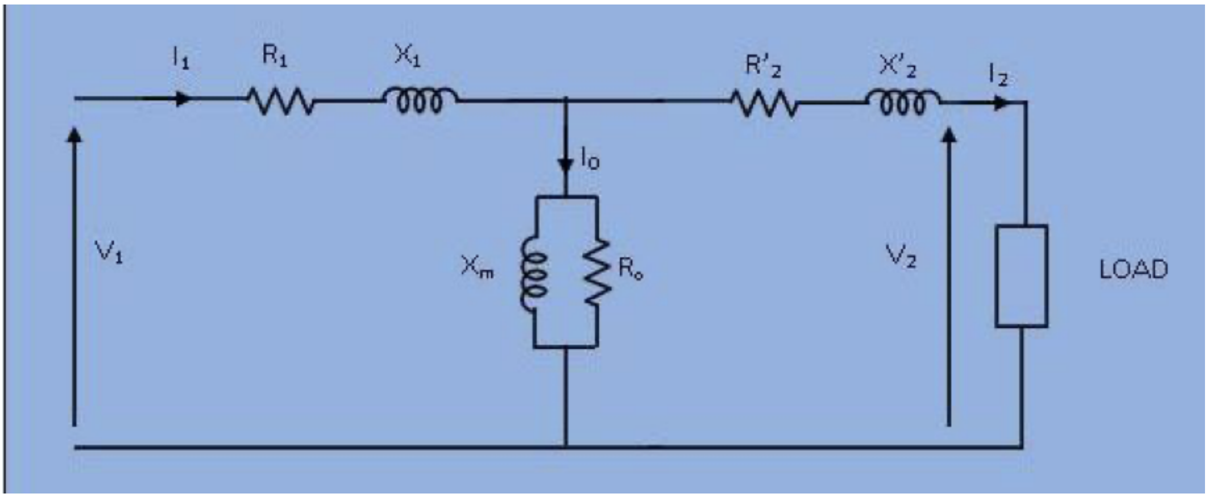
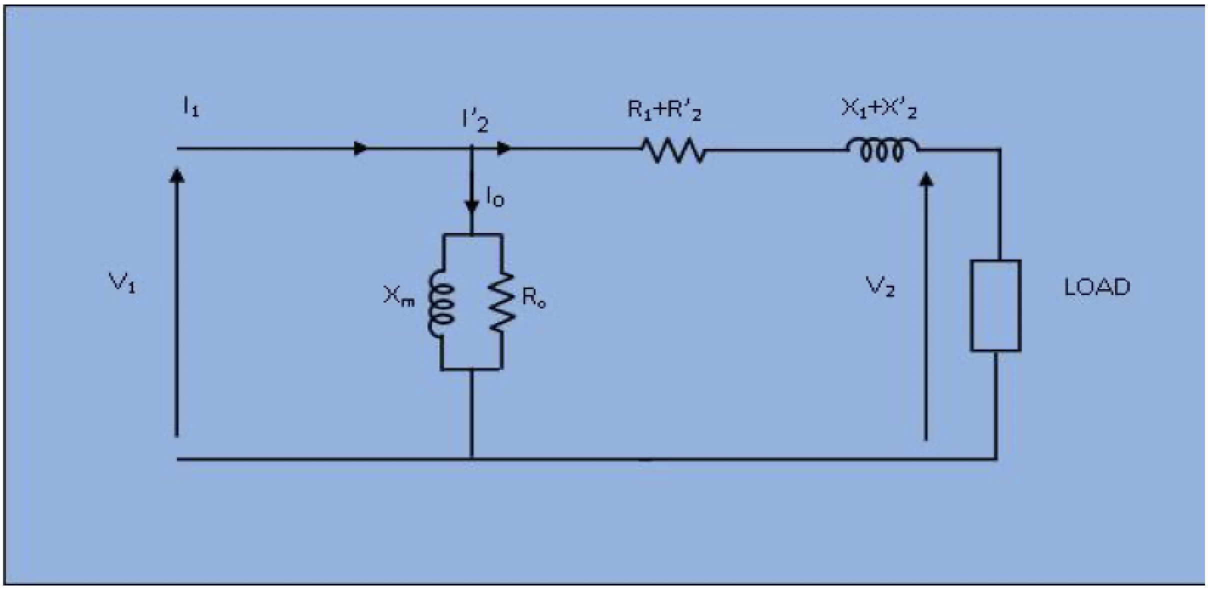


Figure 2(B)

The practical transformer has coils of finite resistance. Though this resistance is actually distributed uniformly, it can be conceived as concentrated. Also, all the flux produced by the primary current cannot confined into a desired path completely as an electric current. On account of the leakage flux, both the windings have a voltage drop which is due to 'leakage reactance’. The transformer shown in the figure 1 can be resolved into an equivalent circuit as shown in figure 2(a) in which the resistance and leakage reactance of primary and secondary respectively are represented by lumped R1, X1, R2 and X2. This equivalent circuit can be simplified by referring all quantities in the secondary side of the transformer to primary side and is shown in figure 2(b).

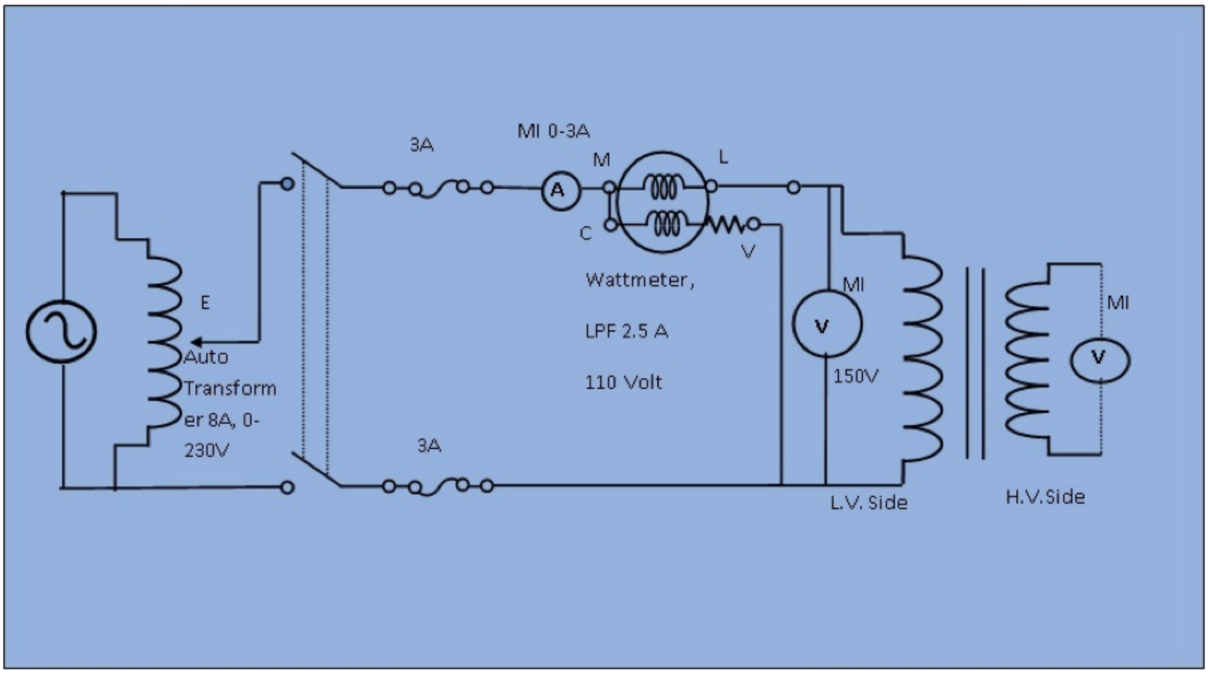
R2'=R2(N1/N2)2 X2'=X2(N1/N2)2 I2'=I2(N2/N1) V2'=V2(N1/N2)

Approximate Equivalent Circuit of Transformer:

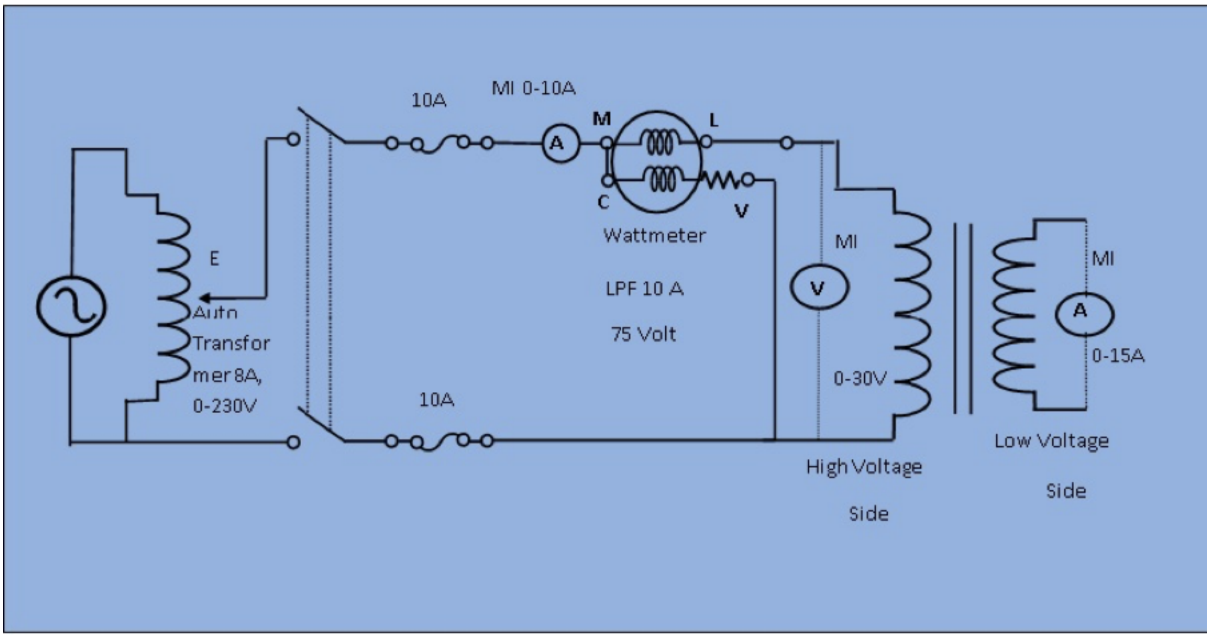


Circuit Diagram –

Equivalent circuit diagram for open circuit test:



Equivalent circuit diagram for short circuit test:



Procedure –

Open Circuit Test:

1. Connect the circuit as shown in circuit Diagram-1, choosing suitable instrument.
2. Switch on the supply, keeping output voltage at auto-transformer at zero. Increase the voltage in set up to rated and tabulated the no load current, input

power and the primary and secondary voltages corresponding to each value of the applied voltage in Table no-1.

The shunt parameters can be determined by performing the test. Since the core loss and magnetizing current depend on applying voltage, this test is performed by applying rated voltage at one winding and other winding keeping open (basically H.V.Side winding is kept open and rated voltage applying at L.V.Side winding). Under no-load condition the power input to the transformer is equal to the sum of losses in the primary winding resistance R1 is neglected and core loss. Since, no load current is very small, the loss in winding resistance is neglected. If Io and Pi are the current and input power drawn by the transformer at rated voltage V1 respectively.Then,

$\cos\zeta o = Pi/(V1 \cdot Io)$

$Ic = Io \cdot \cos\zeta o$ $\quad$ $Im = Io \cdot \sin\zeta o$

$Ro = V1/Ic$ $\quad$ $Xm = V1/Im$

Short Circuit Test:

1. Connect the circuit as shown in circuit diagram-2 ,choosing suitable instrument.
2. Keeping the output voltage of the auto-transformer at zero, switch on the circuit. Increase the output voltage slowly and observe the primary and secondary currents carefully.
3. Adjust the output voltage of the transformer to get secondary short circuit current of 25%, 59%, 75%, 100% of the rated current.

In this test, the L.V.Side terminals are shorted.The primary voltage is gradually applied till the rated current flows in the winding. Since, the applied voltage is very small. The magnetizing branch can now be eleminated from the equivalent circuit. The modified equivalentcircuit is shown in the figure. If Vsc is the applied voltage to circulated the rated current (I'2)on short circuit and Pc is the power input to the transformer.

$Zsc = Vsc/I'2$

$\cos\theta = Pc/(Vsc \cdot I'2)$

$R1 + R'2 = Zsc \cdot \cos\theta$

$X1 + X'2 = Zsc \cdot \sin\theta$

Observation –

Open Circuit Test:

Serial no. of Observation	Primary Voltage V_1 (L.V. Side)	Primary Current I_0 (Amp)	Input Power P_i (Watt)	Secondary Volatge V_2 (H.V.Side)
1st	6.2000	0.064890	0.061631	12.710
2nd	21.500	0.22502	0.74113	44.075
3rd	38.600	0.40399	2.3889	79.130
4th	69.400	0.72635	7.7221	142.27
5th	90.900	0.95137	13.248	186.34

Short Circuit Test:

Serial no. of Observation	Primary Voltage V_1 (H.V. Side)	Primary Current I_1 (Amp)	Input Power P_c (Watt)	Secondary Current I_2 (L.V.Side)
1st	4.6	1.952135231	4.283375124	3.904270462
2nd	10.1000000C	4.286209964	20.64967374	8.57241992E
3rd	12.3	5.219839857	30.62532242	10.43967971
4th	15.2999999S	6.492971530	47.38635552	12.9859430E
5th	17.4	7.384163701	61.28708188	14.7683274C

Result –

Efficiency and Regulation of Single Phase Transformer has been measured successfully using open circuit test and short circuit test.

Conclusion –

1. From the experiment we can see that the voltage is transferred in the
2. Direct ratio of turns.
3. Reverse ratio of current.
4. Direct ratio squared of impedance.
5. Power and voltmeter remain unchanged.

6. Core losses include hysteresis loss and eddy current loss.
7. Open circuit test on transformer give core losses of transformer and shunt parameter.

Precautions –

1. All connections should be neat and tight.
2. While performing experiments take care that the instrument reading should not exceed the readings of the machine under test.
3. Switch off supply when not in use.