I

Name _____

Roll No. _____ Year 20____20____

Exam Seat No. _____

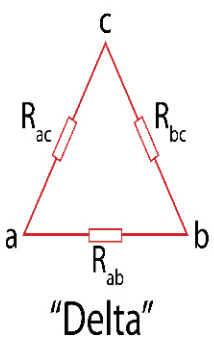
ELECTRICAL GROUP | SEMESTER - III | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL

FOR

ELECTRICAL CIRCUITS

(22324)



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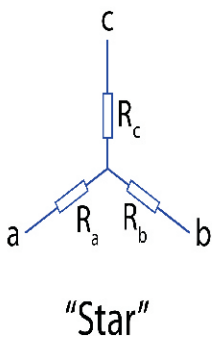

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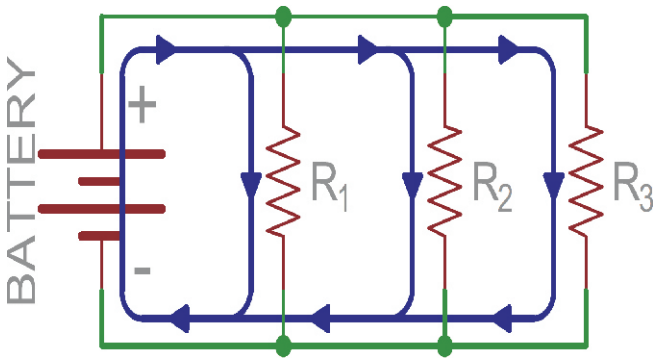
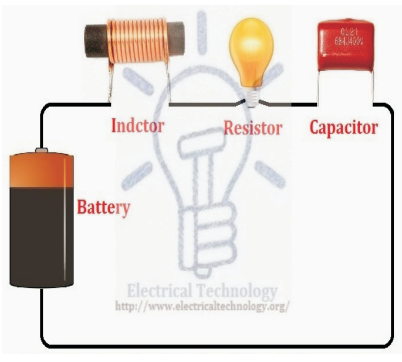




MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual

for

Electrical Circuits

(22324)

Semester-III

(EE/EP/EU)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO:9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO : 9001 : 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on June, 2018)

MAHARASHTRA STATE

BOARD OF TECHNICAL EDUCATION

Certificate

This is to certify that Mr. / Ms. ……..…… Roll No. ……..…., of Third Semester of Diploma in ……..…… of Institute, ……..……..…. (Code: ……...) has completed the term work satisfactorily in course **Electrical Circuits (22324)** for the academic year 20…….. to 20…….. as prescribed in the curriculum.

Place: …… Enrollment No:.……

Date: …… Exam. Seat No: ……

Subject Teacher **Head of the Department** **Principal**

Seal of Institution

Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programmes with outcome-base education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practicals to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practicals to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

To maintain electrical equipments, knowledge of electrical circuits is very important. Understanding electrical circuits lays the foundation to maintain electrical and electronic devices, machines and equipment. This course will help the students to use the principles of circuit and analyze the same to diagnose and rectify the electrical circuits related problems in the industries and power utilities.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome

Programme Outcomes (POs) to be achieved through Practicals of this Course:

PO 1. **Basic knowledge**: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electrical engineering problems.

PO 2. **Discipline knowledge**: Apply Electrical engineering knowledge to solve broad-based electrical engineering related problems.

PO 3. **Experiments and practice**: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.

PO 4**. Engineering tools**: Apply relevant Electrical technologies and tools with an understanding of the limitations.

PO 8. **Individual and team work**: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

PO 9. **Communication**: Communicate effectively in oral and written form.

PO 10**. Life-long learning**: Engage in independent and life-long learning activities in the context of technological changes also in the Electrical engineering and allied industry.

PSO 1. Electrical Equipment: Maintain various types of rotating and static electrical equipment.

PSO 2. Electric Power Systems: Maintain different types of electrical power systems

Practical- Course Outcome matrix

Course Outcomes (COs)

a. Troubleshoot problems related to single phase A.C series circuits.
b. Troubleshoot problems related to single phase A.C parallel circuits.
c. Troubleshoot problems related to three phase circuit.
d. Use principles of circuit analysis to troubleshoot problems related to electric circuits.
e. Apply network theorems to troubleshoot problems related to electric circuits.

S. No.	Title of the Practical	CO a.	CO b.	CO c.	CO d.	CO e.
1.	Use dual trace oscilloscope to determine A.C voltage and current response in given R, L, C circuit.	√	-	-	-	-
2.	Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L series circuit. Draw phasor diagram.	√	-	-	√	-
3.	Use voltmeter, ammeter to determine active, reactive and apparent power consumed in given R-C series circuit. Draw phasor diagram	√	-	-	√	-
4.	Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L-C series circuit. Draw phasor digram	√	-	-	√	-
5.	Use variable frequency supply to create resonance in given series R-L-C circuit or by using variable inductor or variable capacitor	√	-	-	√	-
6.	Use voltmeter, ammeter, wattmeter to determine current, p.f, active, reactive and apparent power in R-C parallel A.C. circuit	-	√	-	√	-
7.	Use voltmeter, ammeter, wattmeter, p.f meter to determine current, p.f., active, reactive and apparent power for given R-L-C parallel circuit with series connection of resistor and inductor in parallel with capacitor.	-	√	-	√	-
8.	Use variable frequency supply create resonance in given parallel R-L-C circuit or by using variable inductor or capacitor	-	√	-	√	-
9.	Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of voltage and current for balanced three phase star and delta connected load and calculate active, reactive, and apparent power. Draw phasor diagram	-	-	√	√	-

10.	Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of voltage and current for unbalanced three phase star and delta connected load and calculate active, reactive, and apparent power. Draw phasor diagram	-	-	√	√	-
11.	Use voltmeter, ammeter to determine current through the given branch of a electric network by applying mesh analysis	-	-	-	√	√
12.	Use voltmeter, ammeter to determine current through the given branch of a electric network by applying node analysis	-	-	-	√	√
13.	Use voltmeter, ammeter to determine current through the given branch and voltage across the given element of circuit by applying superposition theorem	-	-	-	√	√
14.	Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Thevenin's theorem	-	-	-	√	√
15.	Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Norton's theorem	-	-	-	√	√
16.	Use voltmeter, ammeter to determine load resistance for maximum power transfer for a given circuit by applying maximum power transfer theorem	-	-	-	√	√

List of Industry Relevant Skills

The following industry relevant skills of the competency ' **Maintain electrical systems applying AC and DC circuit fundamentals**' are expected to be developed in you by undertaking the practicals of this laboratory manual.

1. Analysis of electric circuits.
2. Use ammeter, voltmeter and wattmeter.

Brief Guidelines to Teachers

1. For incidental writing on the day of each practical session every student should maintain a dated log book for the whole semester, apart from this laboratory manual which s/he has to submit for assessment to the teacher in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters which is not mentioned in the printed practicals.
3. For difficult practicals if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.

(Note: Kindly do add specific guidelines for effective implementation of practicals depending upon your course, if needed.)

Instructions for Students

1. Follow the general laboratory rules and precautions for electrical safety.
2. Use correct/proper power supply.
3. Make sure that all connection are fixed.
4. The connection should be according the circuit diagram.
5. Verify correction from the teacher before switching ON the power supply.

(**Note**: Kindly do add specific instructions for students for effective implementation of practicals depending upon your course, if needed.)

Content Page

List of Practicals and Progressive Assessment Sheet

S. No.	Title of the practical	Page No.	Date of perfor mance	Date of submission	Assessment marks(25)	Dated sign. of teacher	Remarks (if any)
9.	Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of voltage and current for balanced three phase star and delta connected load and calculate active, reactive, and apparent power. Draw phasor diagram	51					
10.	Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of voltage and current for unbalanced three phase star and delta connected load and calculate active, reactive, and apparent power. Draw phasor diagram	57					
11.	Use voltmeter, ammeter to determine current through the given branch of a electric network by applying mesh analysis	63					
12.	Use voltmeter, ammeter to determine current through the given branch of a electric network by applying node analysis	69					
13.	Use voltmeter, ammeter to determine current through the given branch and voltage across the given element of circuit by applying superposition theorem	75					
14.	Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Thevenin's theorem	81					
15.	Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Norton's theorem	87					
16.	Use voltmeter, ammeter to determine load resistance for maximum power transfer for a given circuit by applying maximum power transfer theorem	92					

- **To be transferred to proforma of CIAAN -2017.**

Practical No. 1: Use Dual Trace Oscilloscope to Determine A.C Voltage and Current Response in Given R, L, C Circuit.

I Practical Significance

In the industry environment Electrical Engineering Diploma graduate are expected to handle cathode ray oscilloscope (CRO) to measure basic parameters like voltage, frequency, time period etc. of passive components. Therefore this practical will help you to acquire necessary skills.

II Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.
Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.
Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

i. Select relevant range of CRO
ii. Select suitable passive Electrical components

IV Relevant Course Outcome(s)

1. Troubleshoot problems related to single phase A.C series circuits.

V Practical Outcome

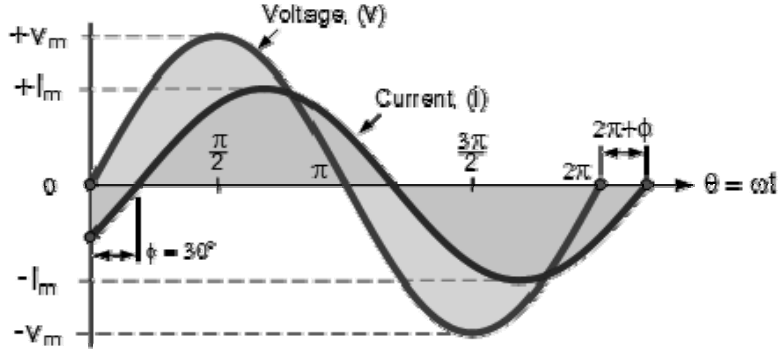
1. Use CRO to observe phase relationship of voltage & current in pure R, pure L & pure C circuit
2. Measure the amplitude of voltage and current by using CRO

VI Relevant Affective domain related Outcome(s)

1. Follow safety electrical rules for safe practices.

VII Minimum Theoretical Background

The phase difference or phase shift between two sinusoidal waveform having same frequency is denoted by an angle "Φ" measured in degree or radians.



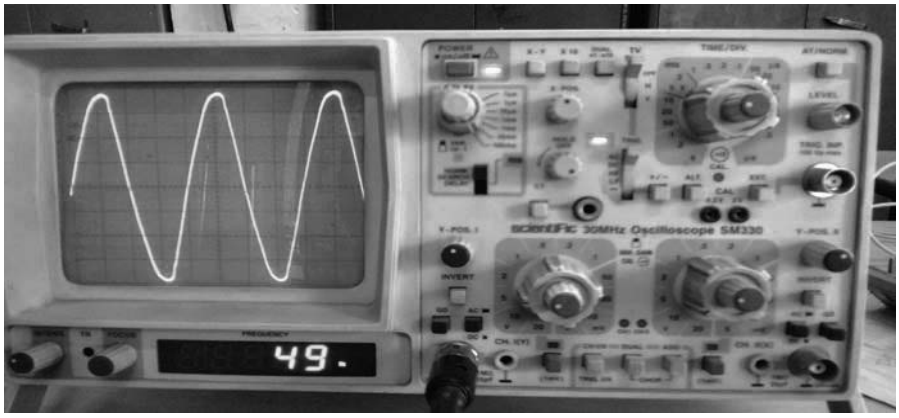
The phase difference, Φ of an alternating waveform can vary between 0 to its maximum time period, T of the waveform during one complete cycle and this can be anywhere along the horizontal axis between, Φ = 0 to 2π (radians) or Φ = 0 to 360° depending upon the angular units used.

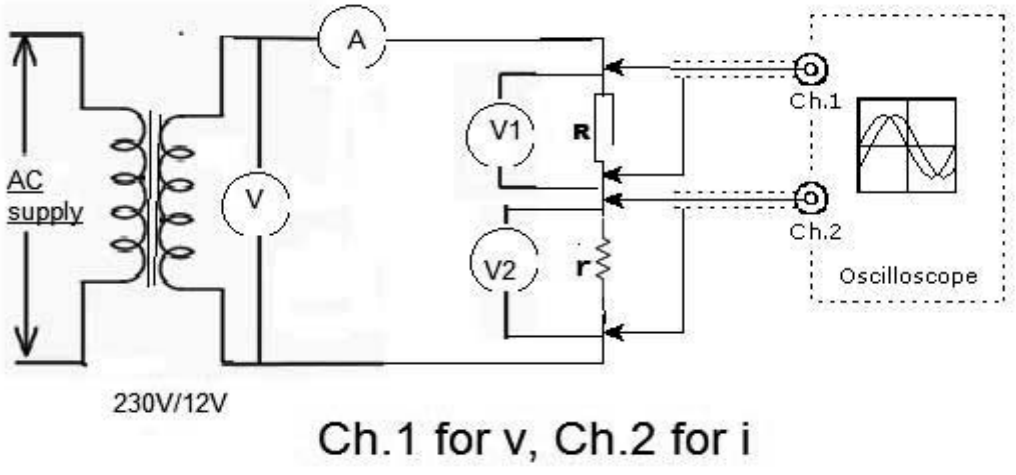
A CRO with two channels should be used since two quantities voltage and current are to be observed. For observing current, it is a usual practice to add a small resistance 'r' in series with the circuit, and the voltage across it is observed, interpreting it as 'current' since the two are in phase.

The equations for the instantaneous value of a sinusoidal voltage or current waveform of passive elements are as follows,

- **$i_r = I_m \sin(\omega t)$, $v_r = V_m \sin(\omega t)$ for resistance**
- **$i_L = I_m \sin(\omega t)$, $v_L = V_m \sin(\omega t - 90)$ for pure inductance**
- **$i_C = Im \sin \omega t$, $v_C = Vm \sin(\omega t + 90)$ for pure capacitance**

VIII Practical set-up / Circuit diagram / Work Situation





(Use L or C instead of R for different responses)

(Student should draw the circuit diagram and get it verified/checked from the concered teacher**.)**

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Resistor	Suitable Resistor	1	
2	Inductor	Suitable Inductor	1	
3	Capacitor	Suitable Capacitor	1	
3	Voltmeter	0-300 V	3	
4	Ammeter	0-5A	1	
5	CRO	20/30/100 MHz Frequency With 2 attenuator probes	1	

X Precautions

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure that the CRO power switch is in off condition.
4. Ensure proper settings of CRO before use.
5. A two winding transformer is required for a lower input voltage and it is also desirable to isolate the circuit from the mains for this experiment. Such an isolation is not obtainable with variac.

XI Procedure

1. Connect the circuit as per circuit diagram.
2. Connect the CRO for observing current and voltage waveform. Channel 1 will show the current waveform and channel 2 will show the voltage waveform.
3. Repeat step 2 for different input voltage.
4. Observe the waveforms for voltage and current in resistance R and find the phase difference between them.
5. Repeat the above procedure for inductive and capacitive loads.
6. Observe the waveforms for voltage and current for passive components and emphasize a quantity, lagging or leading with respect to other quantity.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Qty	Remarks (If any)
		Make	Details		
1					
2					
3					
4					
5					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions to be followed:

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

S. No.	Element	V	V1	V2	Current (I)	Phase difference ϕ
1	**R**					
2	**L**					
3	**C**					
4						

Draw observed waveform of voltage and current of all elements and show the phase angle between them.

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations

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XIX Practical Related Questions

1. With reference to alternating quantities, define the following terms: Waveform, Cycle, Frequency, Amplitude and Time period.
2. Explain the meaning of the terms in phase, lag and lead in relation to alternating quantities.
3. With the help of waveforms and phasor diagrams, comment on the phase relationship between the voltage and the current in pure resistive, pure inductive and pure capacitive circuit.
4. If a sinusoidal voltage v = Vm sin ($\omega t+120^{o}$), then write the expression of current for pure resistive, pure inductive and pure capacitive circuit.

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[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the measuring instruments	10 %
2.	Identification of passive component	20 %
3.	Measuring value using suitable instrument	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculate theoretical values of given component	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 2: Use Voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L series circuit, draw phasor diagram.

I Practical Significance

In the industry environment Electrical Engineering diploma graduate are expected to measure basic parameters like voltage, frequency, time period etc. for R-L series circuits. Therefore this practical will help you to acquire necessary AC series circuits skills.

II Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.
Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.
Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.
Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

i. Select relevant range of meters.
ii. Select suitable resistance and inductance.

IV Relevant Course Outcome(s)

1. Troubleshoot problems related to single phase A.C series circuits.

V. Practical Outcome

1. Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L series circuit. Draw phasor diagram.

VI Relevant Affective domain related Outcome(s)

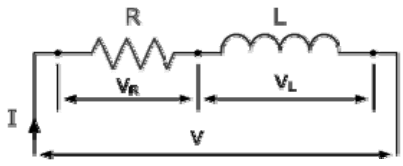
1. Follow safety electrical rules for safe practices.

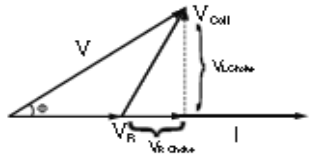
VII Minimum Theoretical Background

Impedance of RL circuit:-Impedance of RL circuit is the phasor sum of resistance and inductive reactance and its unit is Ω.

$$Z = R + j\,X_L = R + j\,\omega L = R + j2\pi f\,L$$

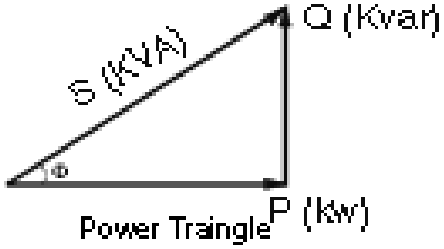
Phasor diagram of RL circuit:- It is the diagram show in phasor relationship between voltages V_R, V_L and V with respect to current I.



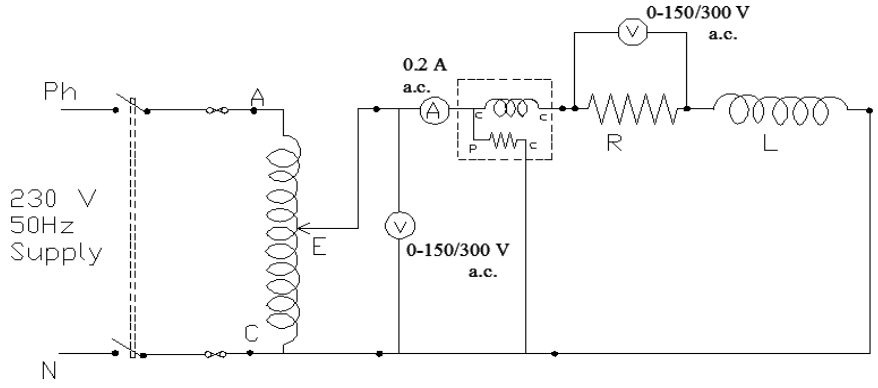


Phasor Diagram

AC power for series RL Circuit:- AC power is the phasor sum of active, reactive and apparent power as shown in power triangle diagram..



VIII Practical set-up / Circuit diagram / Work Situation



(Student should draw the circuit diagram and get it verified/checked from the concerned teacher)

(Space for circuit diagram)

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Rheostat	Suitable Rheostat (0-220ohm,5A)	1	
2	Inductor	Suitable Inductor	1	
3	Voltmeter	0-300 V	3	
4	Ammeter	0-2A	1	
5	Wattmeter	300V, 10A	1	

X Precautions

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.

XI Procedure

1. Connect the circuit as per circuit diagram.
2. Set the rheostat for maximum resistance.
3. Set the variac to zero output and switch on a.c. mains.
4. Apply a suitable voltage adjusting the variac, so that a suitable current flows.
5. Measure and note the voltages across R and L, current and power through it. Also measure the output of voltage of variac.
6. Repeat the above procedure for different output voltages of variac/varying R/varying L.
7. Draw the phasor diagram for each of reading for verification.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Qty	Remarks (If any)
		Make	Details		
1					
2					
3					
4					
5					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Resistance of inductor = r = ……..Ω.

(Measure resistance of inductor or calculate using phasor diagram of observed data)

S. No	Observation				
	Supply Voltage V (Volts)	Current I(amp)	Voltage across resistance V_R (Volts)	Voltage across choke coil V_{Coil} (Volts)	Power P (watts)

S. No	Calculation									Remarks
	Vr = I * r	Voltage across pure inductance $V_L = \sqrt{(V_{Coil}^2 - Vr^2)}$	R= V_R/ I	$X_L=V_L/I$	Z =V/I	Cos(Φ) = P/VI	Φ	Reactive power Q (VAR)	Apparent power S (VA)	

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. Sketch the waveforms of voltage, current and power if $v = V_m \sin \omega t$ is applied across R-L series circuit.
2. Draw phasor diagram of each reading and obtain internal resistance of inductor.
3. Derive expression of average power of R-L series circuit, if applied voltage is v = $v = V_m \sin \omega t$ and $i = I_m \sin (\omega t - \Phi)$
4. Draw power triangle with scale.

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S. Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the measuring instruments	10 %
2	Identification of R and L components and connection of circuit.	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ..……

2. ……

3. ……

Marks Obtained			**Dated signature of Teacher**
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 3: Use Voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-C series circuit, draw phasor diagram.

I. Practical Significance

In the industry environment Electrical Engineering diploma graduate are expected to analyze basic parameters like voltage, frequency, time period etc. for R-C series circuits. Therefore this practical will help you to acquire necessary skills.

II. Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.
Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.
Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.
Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

i. Select relevant range of meters.
ii. Select suitable resistance and capacitance.

IV Relevant Course Outcome(s)

1. Troubleshoot problems related to single phase A.C R-C series circuits.

V Practical Outcome

1. Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-C series circuit. Draw phasor diagram.

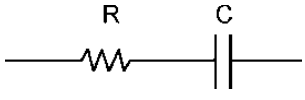
VI Relevant Affective domain related Outcome(s)

1. Follow safety electrical rules for safe practices.

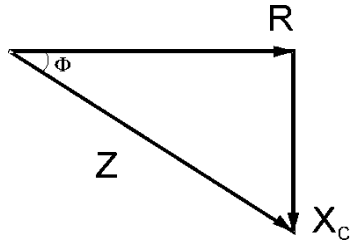
VII Minimum Theoretical Background

Impedance of R-C series circuit:

Impedance of R-C series circuit is the phasor sum of resistance and capacitive reactance.

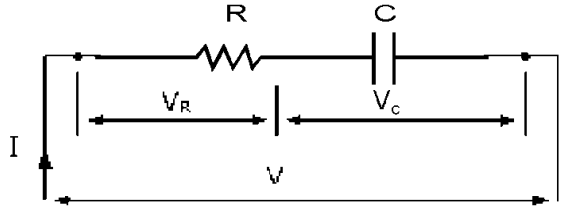
Impedance (Z)	Rectangular form	Polar form
	$Z = R - j X_C$ $Z = R - j (1/2\pi f C)$	$Z = \lvert Z \rvert \angle \Phi$ $Z = \sqrt{R^2+X_c^2} \angle \Phi = \tan^{-1}(-X_C/R)$

Impedance Triangle:

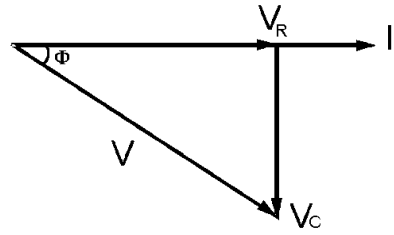


Phasor diagram of R-C series circuit:

It is the diagram showing the phasor relationship between voltages V_R, V_C and V with respect to current I.



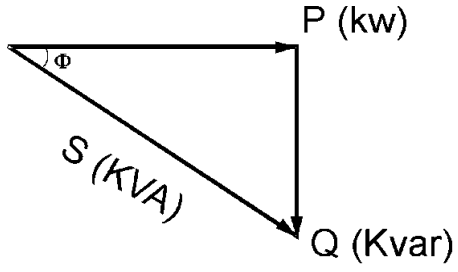
RC circuit



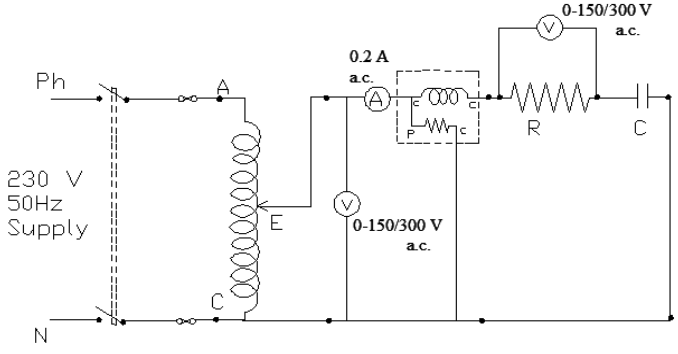
Phasor Diagram

AC power for R-C series circuit:

AC power is the phasor sum of active power (P), reactive power (Q) and apparent power (S).



VIII Practical set-up / Circuit diagram / Work Situation



(Student should draw the circuit diagram and get it verified /checked from the concerned teacher.)

(Space for circuit diagram)

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Rheostat	Suitable Rheostat	1	
2	capacitor	Suitable capacitor	1	
3	Voltmeter	0-300 V	3	
4	Ammeter	0-5A	1	
5	Variac	0-300V	1	
6	Wattmeter	(300V, 5A)	1	

X Precautions

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the output voltage of the variac should be zero.

XI Procedure

1. Make sure that capacitor is discharged.
2. Connect the circuit as per circuit diagram.
3. Set the rheostat for maximum resistance.
4. Set the variac to zero output and switch on a.c. mains.
5. Apply a suitable voltage adjusting the variac, so that a suitable current flows. Measure and note the voltages across R and C, current and power through it. Also measure the output voltage of variac.
6. Repeat the above procedure for different output voltages of variac/varying R/varying C.
7. Reduce the autotransformer position to zero and switch OFF the supply.
8. Draw the phasor diagram.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Qty	Remarks (If any)
		Make	Details		
1					
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XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

S. No	Observation				
	Supply Voltage V Volts	Current I amp	Voltage across resistance V_R Volts	Voltage across capacitor V_c Volts	Power P watts

S. No	Calculation								Remarks
	$R= V_R/ I$	$X_C=V_C/I$	$Cos(\Phi)= P/VI=R/Z$	$Z =V/I$	Φ	Active power $P=VI Cos(\Phi)$	Reactive power $Q=VI Sin(\Phi)$	Apparent power $S= VI$	

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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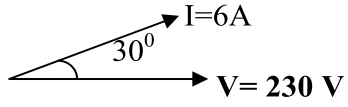
XIX Practical Related Questions

1) What precaution should be taken while working with the capacitor?
2) Calculate the impedance of RC series circuit having resistance of 5Ω and capacitor of 200 μf, when frequency a) f=100Hz. b) f=150Hz. c) f=200 Hz.
3) Sketch the waveform of voltage, current and power if v= V_m sin ωt is applied across R-C series circuit. State the expressions for current and power consumed.
4) Calculate active and reactive power of the circuit for any one set of readings.
5) Draw power triangle with scale.
6) From the phasor diagram calculate the circuit constant if frequency f = 50Hz.



[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the measuring instruments	10 %
2	Identification of R and C component and connection of circuit	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..……..

2. ……..…….

3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 4: Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L-C series circuit, draw phasor diagram

I. Practical Significance

In the industry environment Electrical Engineering diploma graduate are expected to measure basic parameters like voltage, frequency, time period etc. for R-L-C series circuits. Therefore this practical will help you to acquire necessary AC series circuit skills.

II. Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.
Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.
Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.
Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

1. Select relevant range of meters.
2. Select suitable resistance and capacitance.

IV Relevant Course Outcome(s)

1. Troubleshoot problems related to single phase A.C series circuits.

V Practical Outcome

1. Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-C series circuit. Draw phasor diagram.

VI Relevant Affective domain related Outcome(s)

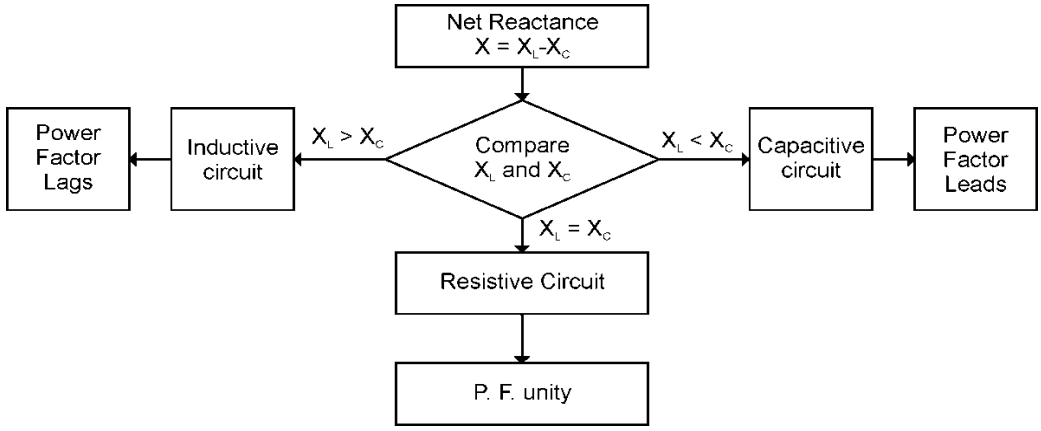
1. Follow safety electrical rules for safe practices.

VII Minimum Theoretical Background

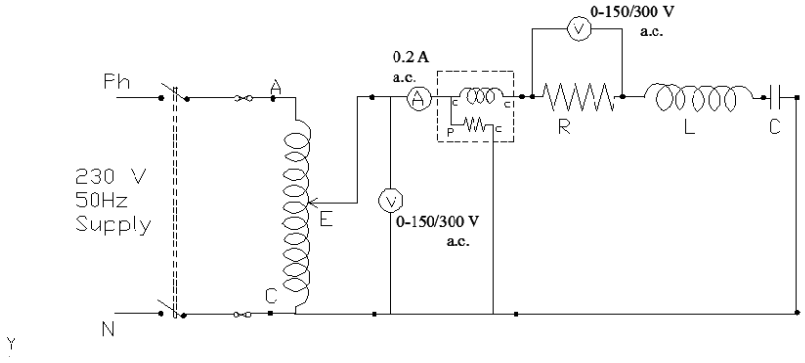
Leading and lagging of the power factor of a circuit depends on the value of net reactance. i.e. $X = X_L - X_C$.

- If $X_L > X_C$, circuit is inductive and power factor lags.
- If $X_L < X_C$, circuit is capacitive and power factor lead.

Flow Diagram of Concept Structure:



VIII Practical set-up / Circuit diagram / Work Situation



(Student should draw the circuit diagram and get it verified /checked from the concerned teacher.) (Space for circuit diagram)

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Rheostat	Suitable Rheostat	1	
2	Capacitor	Suitable capacitor	1	
3	Inductor	Suitable Inductor	1	
4	Voltmeter	0-150-300 V	3	
5	Ammeter	0-2A	1	
6	Variac	0-300V	1	

X Precautions

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the output voltage of the variac should be zero.

XI Procedure

1. Capacitor should be discharge before and after use.
2. Connect the circuit as shown in circuit diagram.
3. Set the rheostat for maximum resistance and conform all meters should be at zero position.
4. Set the variac to zero output and switch on a.c. mains.
5. Apply a suitable voltage adjusting the variac, so that a suitable current flows. Measure and note the voltages across R, L and C, current and power through it. Also measure the output voltage of variac.
6. Repeat the above procedure for different output voltages of variac/varying R/varying C/varying L.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Qty	Remarks (If any)
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1					
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XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Resistance of inductor = r = ……..Ω.
(Measure resistance of inductor or calculate using phasor diagram of observed data)

S. No	Observation						
	Supply Voltage V (Volts)	Current I (amp)	Voltage across resistance V_R (Volts)	Voltage across coil Vcoil (Volts)	Voltage across resistance and coil V_{RL} (Volts)	Voltage across capacitor V_C (Volts)	Power P (watts)

S. No.	Vr = I x r	Voltage across pure inductance $V_L = \sqrt{(Vcoil^2 - Vr^2)}$	R = V_R/ I	Z =V/I	X_L= V_L/I	Xc = Vc/I	Cos(Φ) = P/VI	Φ	Reactive power Q= VI Sin(Φ) (VAR)	Apparent Power S = VI (VA)

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. What is the importance of R in the series circuit?
2. Draw and explain phasor diagram for RLC series circuit for
   a. $X_L > X_C$, b. $X_C > X_L$, c. $X_L = X_C$.
3. Sketch impedance triangle and power triangle diagram with scale.

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the measuring instruments	10 %
2	Identification of R, L and C component and connection of circuit.	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 5: Use variable frequency supply to create resonance in given series R-L-C circuit or by using variable inductor or variable capacitor

I Practical Significance

In the industry environment, Electrical Engineering diploma graduate are expected to measure basic parameters like voltage, current etc. for R-L-C series resonance circuit. Therefore this practical will help you to acquire necessary resonance circuit kills.

II Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.

Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.

Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.

Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

1. Select relevant range of meters.
2. Select suitable resistance inductance and capacitance.

IV Relevant Course Outcome(s)

1. Troubleshoot problems related to single phase A.C series circuits.

V Practical Outcome

1. Use variable frequency supply to create resonance in given series R-L-C circuit or by using variable inductor or variable capacitor

VI Relevant Affective domain related Outcome(s)

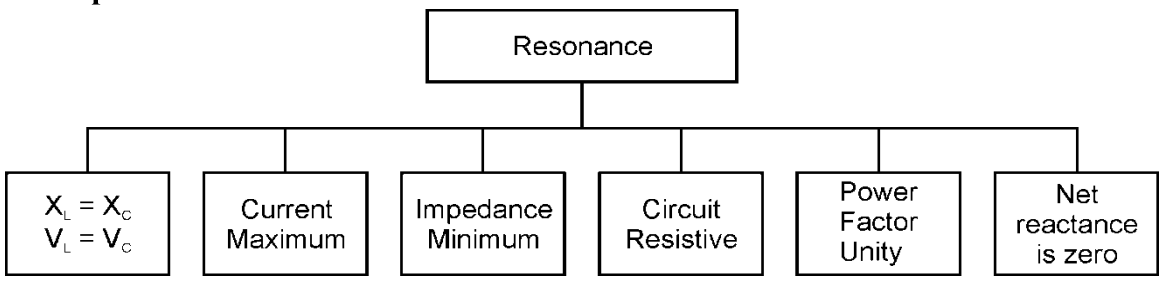
1. Follow safety electrical rules for safe practices.

VII Minimum Theoretical Background

Resonance:

The phenomenon of resonance in R-L-C series circuit is the condition at which the inductive and capacitive reactance's are equal, current in the circuit becomes maximum, impedance of the circuit is minimum, nature of the circuit is resistive, power factor of the circuit is unity and net reactance of the circuit is zero.

Concept Structure:



Resonance frequency (f_0):

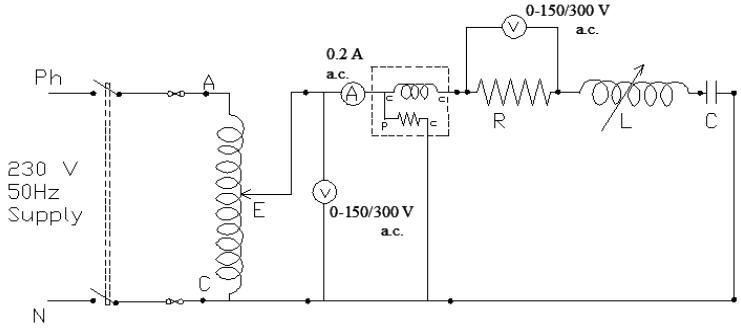
The frequency at which the resonance in series circuit occurs is called as resonance frequency (f_0).

Quality factor (Q):

If the voltage magnification is produced by resonance is called 'Q' factor of the series resonant circuit. Also it is defined as the ratio of inductive reactance to resistance.

$$Q = X_L/R = \omega L/R = 2\pi f L$$

VIII Practical set-up / Circuit diagram / Work Situation



(Student should draw the circuit diagram and get it verified /checked from the concerned teacher.)

(Space for circuit diagram)

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Rheostat	Suitable Rheostat(0-220ohm,5A)	1	
2	capacitor	Suitable capacitor	1	
3	Inductor	Suitable variable Inductor	1	
4	Voltmeter	0-150-300 V	3	
5	Ammeter	0-2A	1	
6	Autotransformer	0-300V	1	

X Precautions

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the output voltage of the Autotransformer should be zero

XI Procedure

1. Capacitor should be discharged before and after use.
2. Connect the circuit as shown in circuit diagram.
3. Confirm all the meters should be at zero position.
4. Keep the knob of autotransformer to zero position and rheostat to maximum position.
5. Switch ON the main supply
6. Increase the voltage in steps such that the voltage across capacitor should not exceed the rated value.
7. Record the readings V, I, V_R, V_L, V_{R+L}, V_C, by varying inductor till you get $V_L = V_C$.
8. Reduce the autotransformer voltage gradually to zero and switch off the supply.
9. Draw the phasor diagram from each reading.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions to be followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Internal resistance of inductor = r = ……Ω

Sr. No.	Observation					
	Supply Voltage	Current	Voltage across resistance	Voltage across inductance	Voltage across R+L	Voltage across capacitor
	V	I	V_R	V_L	V_{R+L}	V_C
	Volts	Amp.	Volts.	Volts.	Volts.	Volts.

Sr. No.	Calculation					
	Impedance	Resistance	Z_L	X_C	X_L	Phase Angle (from phasor diagram) Φ
	Z = V/I	$R = V_R/I$	$Z_L = (V_{R+L})/I$	V_C/I	$X_L = \sqrt{(Z_L^2 - r^2)}$	
	Ω	Ω	Ω	Ω	Ω	

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. What is meant by resonance in R-L-C series circuit? Derive the equation for resonant frequency.
2. Draw the curve showing variation of R, X_L, X_C, Z and current with frequency.
3. Draw phasor diagram at resonance.
4. In series RLC circuit $X_L = X_C$. What is the power factor of the circuit?
5. State the purpose and applications of series resonance circuit.

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the measuring instruments	10 %
2	Identification of R, L and C component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..

2. …….

3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 6: Use voltmeter, ammeter, wattmeter to determine current, power factor, active, reactive and apparent power in R-C parallel A.C. circuit

I Practical Significance

In the industry environment Electrical Engineering diploma graduate are expected to measure basic parameters like voltage, current etc. for R-C parallel circuit. Therefore this practical will help you to acquire necessary parallel circuit skills.

II Relevant Program Outcomes :

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.

Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.

Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.

Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

1. Select relevant range of meters.
2. Select suitable resistance and capacitance.

IV Relevant Course Outcome(s)

1. Troubleshoot problems related to single phase A.C parallel circuits.

V Practical Outcome

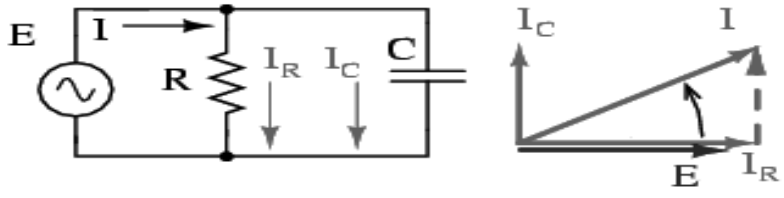
1. Use voltmeter, ammeter, wattmeter to determine current, power factor, active, reactive and apparent power in R-C parallel A.C. circuit

VI Relevant Affective domain related Outcome(s)

1. Follow safety electrical rules for safe practices.

VII Minimum Theoretical Background

Admittance of parallel AC circuit:



$I = I_R + I_C$, $E = E_R = E_C$

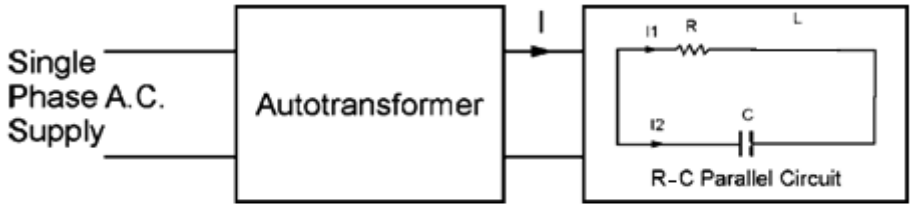
$Z_1 = R$, $Y_1 = 1/R$, $Z_2 = -jX_C$, $Y_2 = 1/-jX_C$, $X_C = 1/(\omega C)$

$Y = Y_1 + Y_2 = 1/R + 1/-jX_C = 1/R + j\,(1/X_C) = G + jB.$

Where, G =1/R, Conductance in Siemens, and $B = 1/X_C$ Susceptant in Siemens.

VIII Practical set-up / Circuit diagram / Work Situation

Block Diagram of R-C parallel circuit



(Student should draw the circuit diagram and get it verified /checked from the concerned teacher.)

(space for circuit diagram)

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Rheostat	Suitable Rheostat	1	
2	Capacitor	Suitable capacitor	1	
3	Voltmeter	0-300 V	1	
4	Ammeter	0-5A	3	
5	Autotransformer	0-300V	1	

X Precautions

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the output voltage of the Autotransformer should be zero.

XI Procedure

1. Capacitor should be discharged before and after use.
2. Connect the circuit as shown in circuit diagram.
3. Confirm all the meters should be at zero position.
4. Keep the knob of autotransformer to zero position and rheostat to maximum position.
5. Switch ON the main supply
6. Record the readings V, I, I_R, I_C, by varying autotransformer voltage gradually.
7. Reduce the autotransformer voltage gradually to zero and switch off the supply.
8. Draw the phasor diagram.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Qty	Remarks (If any)
		Make	Details		
1					
2					
3					
4					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

R = ……Ω, C = ……μf. Measure by using LCR meter:

Table for Observation (Voltages, Currents and Power)

S. N.	Observation					Calculations						
	Supply voltage (In volts)	Total Current (In amp)	Current through R Branch (in amp)	Current through capacitor (in amp)	Power (watt)	Resistance	Capacitive Reactance	Total Impedance	Phase Angle (In degree)	Active power (In kW)	Reactive Power (In VAR)	Apparent Power (In VA)
	V	I	I_R	I_C	P	$R = V_R / I_R$	$X_C = V_C / I_C$	Z = V/I	$\Phi = \cos^{-1}(P/VI)$	P = VI cos Φ	Q = VI sin Φ	S = VI
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XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. State the significance of parallel R-C circuit.
2. Draw phasor diagram with scale.
3. State the probable errors in the experiment.
4. Calculate the admittance, conductance and susceptance for the parallel RC circuit of R=10kΩ, C=100 μf.
5. What will be the main current of R- C parallel circuit, if I_R =10A and I_C = 5A.

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the measuring instruments	10 %
2	Identification of R, L and C component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….

2. …….

3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 7: Use voltmeter, ammeter, wattmeter to determine current, power factor, active, reactive and apparent power for given R-L-C parallel circuit with series connection of resistor and inductor in parallel with capacitor.

I Practical Significance

In the industry environment Electrical Engineering diploma graduate are expected to measure basic parameters like voltage, current etc., for R-L-C parallel circuit. Therefore this practical will help you to acquire necessary a.c. parallel circuit skills.

II Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.

Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.

Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.

Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

1. Select relevant range of meters.
2. Select suitable resistance and capacitance.

IV Relevant Course Outcome(s)

Troubleshoot problems related to single phase A.C parallel circuits.

V Practical Outcome

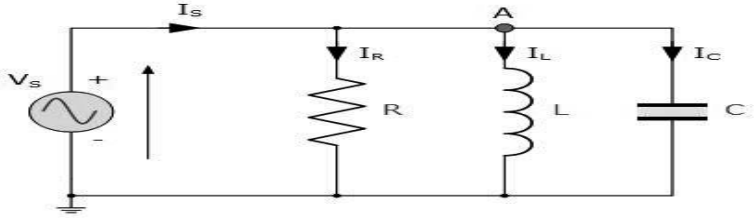
Use voltmeter, ammeter, wattmeter to determine current, power factor, active, reactive and apparent power for given R-L-C parallel circuit with series connection of resistor and inductor in parallel with capacitor

VI Relevant Affective domain related Outcome(s)

Follow safety electrical rules for safe practices.

VII Minimum Theoretical Background

Admittance of parallel R-L-C AC circuit:



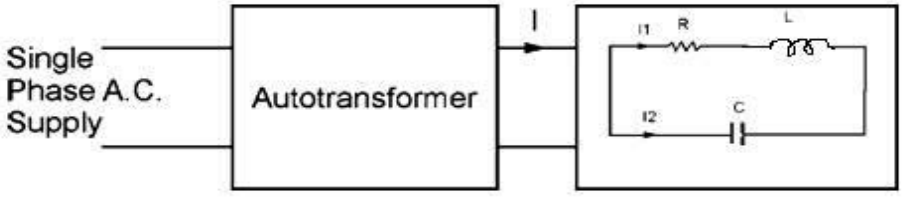
$Z_1 = R$, $Y_1 = 1/R$, $Z_2 = jX_L$, $Y_2 = 1/jX_L$, $Z_3 = -jX_c$, $Y_3 = 1/-jX_c$

$Y = Y_1+Y_2+Y_3$, $Y = 1/R + 1/jX_L+1/-jX_c$, $Y = 1/R + j\,(1/X_c - 1/X_L)$, $Y = G+jB$

Where, G = 1/R conductance of parallel circuit, $B = (1/X_c - 1/X_L)$ Susceptance of parallel circuit.

VIII Practical set-up / Circuit diagram / Work Situation

Block Diagram of R-L in parallel with C circuit.



R-L parallel with C

(Student should draw the circuit diagram and get it verified /checked from the concerned teacher.)

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Rheostat	Suitable Rheostat (0-20ohm,5A)	1	
2	Inductor	Suitable inductor (30mH)	1	
3	capacitor	Suitable capacitor (100μF)	1	
4	Voltmeter	0-300 V	3	
5	Ammeter	0-5A	1	
6	Autotransformer	0-300V	1	

X Precautions

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the output voltage of the Autotransformer should be zero.

XI Procedure

1. Capacitor should be discharged before and after use.
2. Connect the circuit as shown in circuit diagram.
3. Confirm all the meters should be at zero position.
4. Keep the knob of autotransformer to zero position and rheostat to maximum position.
5. Switch ON the main supply
6. Record the readings V, I, I_R and I_C by varying autotransformer voltage gradually
7. Reduce the autotransformer voltage gradually to zero and switch off the supply.
8. Draw the phasor diagram from each reading.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions to be followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

By LCR meter:

R = ……Ω, L = …….. mH, C = ……µf,

Internal resistance of inductor, r = Ω

Table for Observation (Voltages, Currents and Power)

S.N.	Supply voltage (In volts)	Total Current (In amp)	Current through R & L Branch (in amp)	Current through capacitor (in amp)	Voltage across resistance (in volts)	Voltage across inductor (in volts)	Voltage across capacitor (in volts)	Active power (in Watts)
.	V	I	I_L	I_C	V_R	V_L	V_C	P
1								
2								
3								

Table for Calculations:

S.N.	Resistance (In Ω)	Inductive Reactance (In Ω)	Capacitive Reactance (In Ω)	Total Impedance (In Ω)	Phase Angle (In degree)	Reactive Power (In VAR)	Apparent Power (In VA)
	$R= V_R /I_L$	$X_L = V_L /I_L$	$X_C = V_C /I_C$	$Z = V/I$	$\Phi= \cos^{-1}$ (P/VI)	$Q = VI \sin \Phi$	$S = VI$
1							
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3							

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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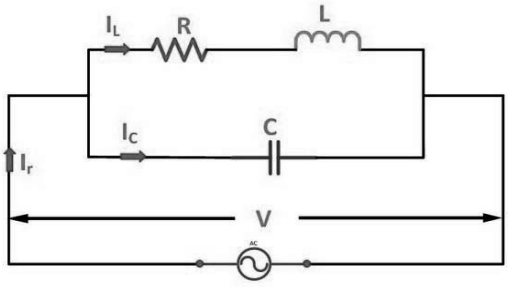
XIX Practical Related Questions

1. State the probable errors in the experiment.
2. State the purpose and applications of parallel circuit.
3. Draw phasor diagram for parallel RLC circuit for $X_L > X_C$, and $X_L < X_C$.
4. RLC parallel circuit shown in figure consume 100 watt. Calculate the current in the inductor I_L if R = 25Ω.



5. Calculate the total admittance, susceptance, and conductance for parallel RLC circuit having R = 10 Ω , L= 20mH and C = 100 μf, frequency f =50 Hz.

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the measuring instruments	10 %
2	Identification of R, L and C component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 8: Use Variable Frequency Supply Create Resonance in Given Parallel R-L-C Circuit or By Using Variable Inductor or Capacitor

I Practical Significance

In the industry environment Electrical Engineering diploma graduate are expected to create & understand parallel resonance for R-L-C parallel circuit. Therefore this practical will help you to acquire necessary skills.

II Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.

Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.

Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.

Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

i. Select relevant range of meters.
ii. Select suitable resistance and capacitance.

IV Relevant Course Outcome(s)

Troubleshoot problems related to single phase A.C parallel circuits.

V Practical Outcome

Use variable frequency supply create resonance in given parallel R-L-C circuit or by using variable inductor or capacitor

VI Relevant Affective domain related Outcome(s)

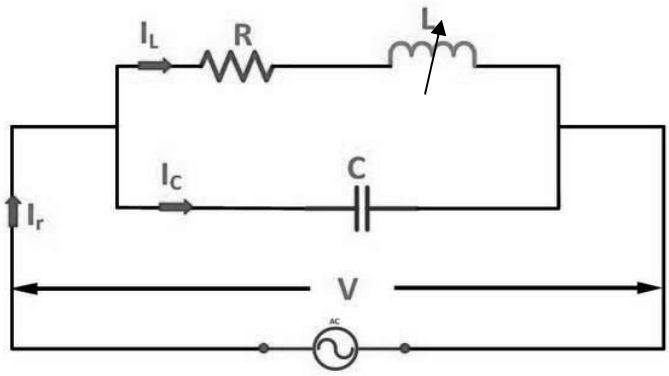
Follow safety electrical rules for safe practices.

VII Minimum Theoretical Background

The condition of the resonance in parallel circuit is as follows,

- The net susceptance of the whole circuit is zero.
- Impedance of the circuit is maximum and is equal to L/CR
- Current in the circuit is minimum and is equal to V/ (L/CR).
- Nature of the circuit is resistive and power factor of the circuit becomes unity.

VIII Practical set-up / Circuit diagram / Work Situation



(Student should draw the circuit diagram and get it verified /checked from the concerned teacher.)

(Space for circuit diagram)

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Rheostat	Suitable Rheostat(0-20ohm,5A)	1	
2	Inductor	Suitable variable inductor(30mH)	1	
3	capacitor	Suitable variable capacitor(100μF)	1	
4	Voltmeter	0-300 V	1	
5	Ammeter	0-5A	3	
6	Autotransformer	0-300V,10A	1	

X Precautions

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the output voltage of the Autotransformer should be zero.

XI Procedure

1. Capacitor should be discharged before and after use.
2. Connect the circuit as shown in circuit diagram.
3. Confirm all the meters should be at zero position.
4. Switch ON the supply
5. Record the readings V, I, I_L and I_C by varying input frequency or inductance or capacitance gradually, till you get minimum current.
6. Reduce the autotransformer voltage gradually to zero and switch off the supply.
7. Draw the phasor diagram.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Qty	Remarks (If any)
		Make	Details		
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XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions to be followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

R = …….Ω, L = …….. mH, C = ……µf , Measure by LCR meter

Table for Observation (Voltages, Currents and Power)

S.N.	Supply frequency(In Hz)	Total Current (In amp)	Current through R_L Branch (in amp)	Current through capacitor (in amp)	Voltage across resistance (in volts)	Voltage across inductor (in volts)	Voltage across capacitor (in volts)	Active power (in Watts)
	V	I	I_L	I_C	V_R	V_L	V_C	P
1								
2								
3								

Table for Calculations:

S.N.	Resistance (In Ω)	Inductive Reactance (In Ω)	Capacitive Reactance (In Ω)	Total Impedance (In Ω)	Phase Angle (In degree)	Reactive Power (In VAR)	Apparent Power (In VA)
	$R= V_R /I_1$	$X_L = V_L /I_L$	$X_C = V_C /I_C$	$Z = V/I$	$\phi = \cos^{-1}$ (P/VI)	$Q = VI \sin\phi$	$S = VI$
1							
2							
3							

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. What is meant by resonance in R-L-C parallel circuit? Derive the equation for resonant frequency.
2. Draw graphically representation of parallel resonance.
3. Draw phasor diagram under resonance.
4. Define quality factor, and calculate its value.
5. State the purpose and applications of parallel resonance circuit.
6. Calculate the net reactance at the resonant frequency for parallel circuit of L=20mH and C=8μf. Also calculate the net reactance at frequency 2fo and fo/2, where fo is the resonance frequency.

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the measuring instruments	10 %
2	Identification of R, L and C component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..

2. ……..

3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 9: Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of voltage and current for balanced three phase star & delta connected load and calculate active, reactive and apparent power. Draw phasor diagram.

I Practical Significance

In the industry environment Electrical Engineering diploma graduate are expected to understand three phase circuit. In practice, large power applications (synchronous machines & Transformers, Transmission line) use three phase systems. In a three phase circuit loads can be connected in balanced star and delta mode. It is necessary to formulate voltage and current relations for system parameters for testing, calculations and interpretations. Therefore this practical will help you to acquire necessary polyphase circuit skills.

II Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.
Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.
Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.
Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

i. Measure electrical quantities.
ii. Circuit connection.
iii. Follow safe practices

IV Relevant Course Outcome(s)

Troubleshoot problems related to three phase circuit.

V Practical Outcome

Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of voltage and current for balanced three phase star and delta connected load and calculate active, reactive, and apparent power. Draw phasor diagram

VI Relevant Affective domain related Outcome(s)

Follow safety electrical rules for safe practices.

VII Minimum Theoretical Background

Three phase electrical supply systems have become popular due to the following advantages,

- The three - phase systems are most economical from the point of view of generation, transmission, distribution and utilization. If a given volume of material can handle P watts of power in a single-phase system, it can handle (1.5 x P) watts of power in a three phase system.

- Performance of three-phase generators and motors run smoothly, with no torque pulsations, unlike single phase machines

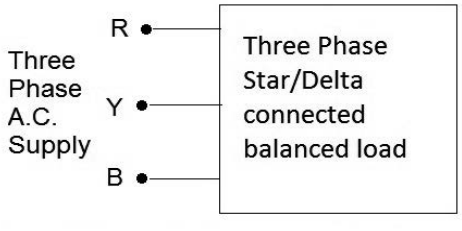
Three phase balanced supply:- Three phase supply is said to be a balance supply if the magnitude of three voltages is equal and displace from each other by 120^0. For balanced three phase supply phasor sum of three voltages is zero.

Balanced Load: - Load is generally given by impedance in Ω. Three phase load is said to be a balanced load if the impedance of each phase is equal in magnitude and having phase angle. (i.e., $\overline{Z_R} = \overline{Z_Y} = \overline{Z_B} = Z\angle\Phi$)

Line voltage: - The voltage between any two phases is known as line voltage (V_L).
(Example: V_{RY}, V_{YB}, V_{BR}).

Phase voltage: - The voltage between any phase with respect to neutral is known as phase voltage ($V_{PH)}$. (Example: V_{RN}, V_{YN}, V_{BN} or V_R, V_Y, V_B).

VIII Practical set-up / Circuit diagram / Work Situation



(Student should draw the circuit diagram and get it verified /checked from the concerned teacher.)

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Three phase variac	Suitable Three phase variac	1	
2	Three phase load	Suitable Three phase load	1	
3	Ammeter	Suitable Ammeters	3	
4	Voltmeter	Suitable Voltmeters	2	
5	Wattmeter	Suitable Wattmeter's	2	
4	Power Factor meter	Suitable Power Factor meter	1	

X Precautions

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the output voltage of the Autotransformer should be zero.

XI Procedure

1. Connect the circuit as shown in circuit diagram.
2. Confirm all the meters should be at zero position.
3. Set the rheostat at maximum position.
4. Set the autotransformer output voltage zero.
5. Switch ON the supply.
6. Record the readings of ammeters, voltmeters, wattmeter's and power factor meter.
7. Take different readings without exceeding the current limits.
8. Perform the experiment with three similar impedances.
9. Use suitable inductors or capacitors in series with the rheostat.
10. Note that the inductors must be similar for the balanced condition
11. Repeat the same procedure for balanced delta connected load
12. Calculate the line voltage from the phase voltage readings and verify the same from the observation noted.
13. Reduce the autotransformer voltage gradually to zero and switch off the supply.
14. Draw the phasor diagram from each reading.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions to be followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Part (A) Balanced star connected load

S. No	Line voltage V_L	Phase voltage V_{PH}	Line current I_L	Phase current I_{PH}	W_1	W_2	Cos ϕ	Ratio I_L/I_{PH}	Ratio V_L/V_{PH}	Active power P	Reactive power Q	Apparent power S
1												
2												
3												

Part (B) Balanced delta connected load

S. No	Line voltage V_L	Phase voltage V_{PH}	Line current I_L	Phase current I_{PH}	W_1	W_2	Cos ϕ	Ratio I_L/I_{PH}	Ratio V_L/V_{PH}	Active power P	Reactive power Q	Apparent power S
1												
2												
3												

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. How to obtain 230 V, single phase supply from 440 V, 3-phase supply.
2. State the applications where the star and delta connections are used.
3. What will be the value of neutral current for three phase star connected balanced load?
4. What will happen if one of the branches gets disconnected?
5. State the methods to measure power in three phase circuit.
6. State the advantages of three phase four wire supply system for distribution purposes.

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the measuring instruments	10 %
2	Identification of R, L and C component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..

2. …….

3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 10: Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of voltage and current for unbalanced three phase star & delta connected load and calculate active, reactive, and apparent power. Draw phasor diagram.

I Practical Significance

In the industry environment Electrical Engineering diploma graduate are expected to understand three phase circuit. In practice large power applications (Synchronous machines & power transformer) use three phase systems. In a three phase circuit loads connected may be in unbalanced star & delta mode. It is necessary to formulate voltage and current relations for system parameters for calculations and interpretations. Therefore this practical will help you to acquire necessary skills.

II Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.
Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.
Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.
Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

i. Measure electrical quantities.
ii. Three phase Circuit connection.
iii. Follow safe practices

IV Relevant Course Outcome(s)

Troubleshoot problems related to three phase circuit.

V Practical Outcome

Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of voltage and current for unbalanced three phase star and delta connected load and calculate active, reactive, and apparent power. Draw phasor diagram

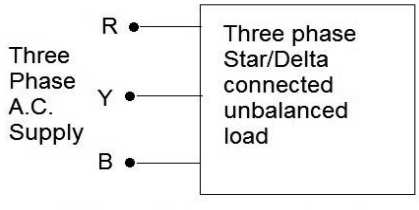
VI Relevant Affective domain related Outcome(s)

Follow safety electrical rules for safe practices.

VII Minimum Theoretical Background

Three phase unbalanced supply:- Three phase supply is said to be a unbalance supply if the magnitude or phase angle is difference in each phase. For unbalanced three phase supply phasor sum of three voltages is not equal to zero.
Unbalanced Load: - Load is generally given by impedance in **Ω**. Three phase load is said to be a unbalanced load if the impedance of each phase is not equal in magnitude and also phase angle. (i.e., $Z_R \neq Z_Y \neq Z_B$)

VIII Practical set-up / Circuit diagram / Work Situation



(Student should draw the circuit diagram and get it verified /checked from the concerned teacher.)

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Three phase variac	Suitable Three phase variac	1	
2	Three phase load	Suitable Three phase load	1	
3	Ammeter	Suitable Ammeters	2	
4	Voltmeter	Suitable Voltmeters	2	
5	Wattmeter	Suitable Wattmeter's	2	
4	Power Factor meter	Suitable Power Factor meter	1	

X Precautions to be followed

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the output voltage of the Autotransformer should be zero.

XI Procedure

1. Connect the circuit as shown in circuit diagram.
2. Confirm all the meters should be at zero position.
3. Set the rheostat at maximum position.
4. Set the autotransformer output voltage is zero.
4. Switch ON the supply.
5. Record the readings of ammeters, voltmeters, wattmeter's and power factor meter.
6. Take different readings without exceeding the current limits.
7. Use suitable inductors or capacitors in series with the rheostat to create *unbalanced star* connected load.
10. Repeat the same procedure for *unbalanced delta* connected load.
11. Calculate the line voltage from the phase voltage readings and verify the same from the observation noted.
12. Reduce the autotransformer voltage gradually to zero and switch off the supply.
13. Draw the phasor diagram from any one reading.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Qty	Remarks (If any)
		Make	Details		
1					
2					
3					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions to be followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Part (A) Unbalanced star connected load

S. No	Line voltage V_L	Phase voltage V_{PH}	Line current I_L	Phase current I_{PH}	W_1	W_2	Cos(Φ)	Ratio I_L/I_{PH}	Ratio V_L/V_{PH}	Active power P	Reactive power Q	Apparent power S
1												
2												
3												

Part (B) Unbalanced delta connected load

S. No	Line voltage V_L	Phase voltage V_{PH}	Line current I_L	Phase current I_{PH}	W_1	W_2	Cos(Φ)	Ratio I_L/I_{PH}	Ratio V_L/V_{PH}	Active power P	Reactive power Q	Apparent power S
1												
2												
3												

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. State any four reasons of unbalanced the load in electrical system.
2. Write value of neutral current and neutral voltage in unbalanced star connected load.
3. Write the effects of unbalanced load on the electrical system.
4. What will happen if one of the fuses blows off in three phase unbalanced load?

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the measuring instruments	10 %
2.	Identification of R, L and C component	20 %
3.	Measuring value using suitable instrument	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculate theoretical values of given component	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. ……..
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 11: Use voltmeter, ammeter to determine current through the given branch of a electric network by applying mesh analysis.

I Practical Significance

In the industry environment Electrical Engineering diploma graduate are expected to understand the network analysis. The Electrical circuit for different systems involves a number of branches. Measurement of current, & voltage across a branch is required for analysis of electrical networks. These parameters can be calculated using Mesh Analysis of the given circuit. This experiment will help you to verify the theoretically obtained current through a branch using mesh analysis.

II Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.

Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.

Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.

Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

i. Measure electrical quantities.
ii. Circuit connection.
iii. Follow safe practices.

IV Relevant Course Outcome(s)

Use principles of circuit analysis to troubleshoot problems related to electrical circuit.

V Practical Outcome

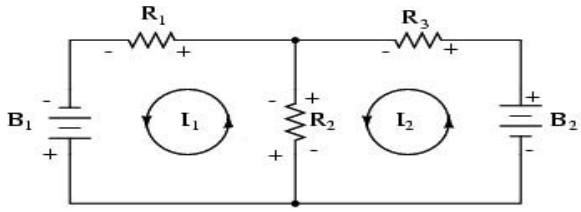
Use voltmeter, ammeter to determine current through the given branch of a electric network by applying mesh analysis.

VI Relevant Affective domain related Outcome(s)

Follow safety electrical rules for safe practices.

VII Minimum Theoretical Background

In this method of analysis, Kirchhoff's Voltage Law is applied to a closed loop network. Mesh equations in terms of mesh currents can be written. By solving simultaneous linear equations for multiple meshes, current through particular branch can be found out.



Mesh equations

$(I_1 - I_2)R_2 + I_1R_1 - B_1 = 0$

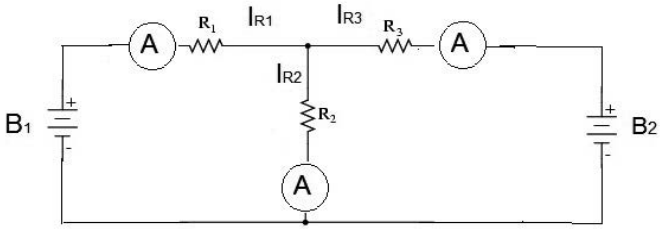
$I_2R_3 - (I_1 - I_2)R_2 - B_2 = 0$

Simplified

$(R_1 + R_2)I_1 - R_2I_2 = B_1$

$-R_2I_1 + (R_2 + R_3)I_2 = B_2$

VIII Practical set-up / Circuit diagram / Work Situation



(Student should draw the circuit diagram with necessary meters and get it verified /checked from the concerned teacher)

(Space for circuit diagram)

IX Resources Required

S. No	Measurement					Calculation by using mesh analysis		
	V_{B1}	V_{B2}	I_{R1}	I_{R2}	I_{R3}	I_{R1}	I_{R2}	I_{R3}

S. No.	Instrument /Components	Specification	Quantity	Remarks
1	Resistors	100 ohm, 5 A	3	
2	Ammeter	5A(DC)	3	
3	Voltage source	110V DC	2	
4	Voltmeter	0 to 300V	1	

X Precautions to be followed

1. Ensure proper connection of resistances and the meters.
2. Ensure the power switch is in 'off' condition initially.

XI Procedure

1. Connect the circuit as shown in circuit diagram.
2. Confirm all the meters should be at zero position.
3. Switch ON the supply.
4. Record the readings of ammeters.
5. Take different readings without exceeding the current limits.
6. Switch off the supply

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					
4					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions to be followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Calculations: Write Kirchhoff's Voltage Equations for the meshes. Simplify the equations. Write the equations in matrix form & find the values of mesh currents and branch current

XVI Results

1. Observed value of current through branch I_{R2} =
2. Calculated value of current through branch I_{R2} =

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. Write steps of mesh analysis of electrical networks.
2. Explain when mesh analysis method is suitable for analysis of network.
3. What are the limitations of mesh analysis?
4. State Kirchhoff's voltage law. Define voltage drop and voltage rise with example.

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the measuring instruments.	10 %
2.	Build circuit for mesh analysis	20 %
3.	Measuring value using suitable instrument	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculate theoretical values of given circuit mesh current	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……..
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 12: Use voltmeter, ammeter to determine current through the given branch of a electric network by applying nodal analysis.

I Practical Significance

In the industry environment Electrical Engineering diploma graduate are expected to understand the network analysis. The Electrical circuit for different systems involves a number of branches. Measurement of current & voltage across a branch is required for analysis of electrical networks. These parameters can be calculated using nodal analysis of the given circuit. This experiment will help you to verify the theoretically obtained voltage across a branch using nodal analysis.

II Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.
Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.
Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.
Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

i. Measure electrical quantities.
ii. Circuit connection.
iii. Follow safe practices

IV Relevant Course Outcome(s)

Use principles of circuit analysis to troubleshoot problems related to electrical circuit.

V Practical Outcome

Use voltmeter, ammeter to determine current through the given branch of a electric network by applying nodal analysis.

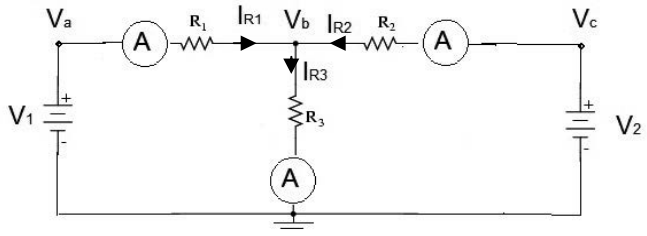
VI Relevant Affective domain related Outcome(s)

Follow safety electrical rules for safe practices.

VII Minimum Theoretical Background

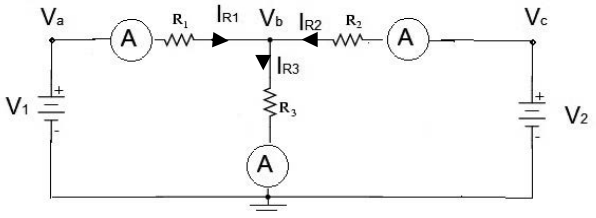
The method of nodal analysis is mainly based on Kirchhoff's current law. Every junction point in a network where three or more branches meet is called a node. One of the node is regarded as the reference node or datum node or zero potential node. The potentials of the other nodes are then assumed with respect to this arbitrarily chosen zero potential node. The potential equations are then written for all the nodes using Kirchhoff's current law. Similar to mesh analysis, this method also reduced the number of independent equations to be solved. If n is the number of

independent nodes, the number of simultaneous equations to be solved becomes (n-1). To determine the node potentials and thereafter, the branch currents can be calculated.



Apply KCL at node b, $I_{R1}+I_{R2}=I_{R3}$, $[(Va-Vb)/R_1]+[(Vc-Vb)/R_2]=Vb/R_3$.-------- (1) In this circuit diagram the value of node potential Va is V_1 and node potential Vb is V_2. In equation (1) only one unknown variable is Vb. The unknown node potential Vb is obtained by solving equation (1).

VIII Practical set-up / Circuit diagram / Work Situation



(Student should draw the circuit diagram with necessary meters and get it verified /checked from the concerned teacher.)

(Space for circuit diagram)

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1	Resistors	Suitable Resistors	3	
2	Ammeter	Suitable Ammeter	3	
3	Voltage source	Suitable voltage sources	2	
4	Multimeter	Suitable Multimeter	1	

X Precautions to be followed

1. Ensure proper connection of resistances and the meters.
2. Ensure the power switch is in 'off' condition initially.

XI Procedure

1. Connect the circuit as shown in circuit diagram.
2. Confirm all the meters should be at zero position.
3. Switch ON the supply.
4. Record the readings of ammeters and potential at each nodes
5. Take different readings without exceeding the current limits.
6. Switch off the supply

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions to be followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 1: Observed & Calculated value of voltage/current

Sr. No.	Observed Voltage /current					Calculated Voltage /current				
	V_a	V_b	V_c	V_{R3}	I_3	V_a	V_b	V_c	V_{R3}	I_3
1										
2										

Calculations: Write Kirchhoff's current Equations for the nodes. Simplify the equations. Write the equations in matrix form & find the values of node potential and voltage across branches.

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. Write steps of nodal analysis of electrical networks.
2. Explain when nodal analysis method is suitable for analysis of network.
3. What are the limitations of nodal analysis?
4. Write difference between mesh and nodal analysis**.**

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the measuring instruments.	10 %
2.	Build circuit for mesh analysis	20 %
3.	Measuring value using suitable instrument	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculate theoretical values of given circuit mesh current	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……..
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 13: Use voltmeter, ammeter to determine current through the given branch and voltage across the given element of circuit by applying superposition theorem.

I Practical Significance

The Electrical & Electronic circuit for different systems involves a number of branches. Many a times as per the requirement, measurement of current, voltage across a branch is required. These parameters of the circuit can be calculated using Superposition theorem in a network having more than one sources. This experiment will help you to verify the theoretically obtained current through a branch using superposition theorem.

II Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.

Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.

Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.

Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

i. Measure electrical quantities.
ii. Follow safe practices

IV Relevant Course Outcome(s)

Apply network theorems to troubleshoot problems related to electric circuits.

V Practical Outcome

Use voltmeter, ammeter to determine current through the given branch and voltage across the given element of circuit by applying superposition theorem.

VI Relevant Affective domain related Outcome(s)

Follow safety electrical rules for safe practices.

VII Minimum Theoretical Background

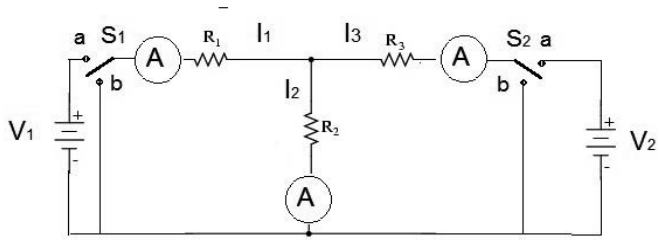
Superposing theorem

For a linear system the response (voltage or current) in any branch of a bilateral circuit having more than one independent source, equals the algebraic sum of the responses caused by each independent sources acting alone, where all the other independent sources are replaced by their internal impedances.

Deactivation of sources

1. Voltage source is deactivated by short circuit it leaving behind its internal impedance if any.
2. Current source is deactivated by open circuit it leaving behind its internal impedance if any.

VIII Practical set-up / Circuit diagram / Work Situation



(Student should draw the circuit diagram and get it verified /checked from the concerned teacher.)

(Space for circuit diagram)

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Ammeter	Suitable Ammeters	3	
2	Voltmeter	Suitable Voltmeters	1	
3	Rheostat	Suitable Rheostat	3	
4	Voltage Source	Suitable Voltage Sources	2	
5	Multimeter	Suitable Multimeter	1	

X Precautions

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.

XI Procedure

1. Connect the circuit as shown in circuit diagram.
2. Confirm all the meters should be at zero position.
3. Set the rheostat at suitable position.
4. Switch ON voltage source V_1 by connecting switch S_1 to 'a' and note down the corresponding ammeter readings I_1`, $I_2$` and I_3`. (Short circuit voltage source V_2 by connecting switch S_2 to 'b').
5. Switch ON voltage source V_2 by connecting switch S_2 to 'a' and note down the corresponding ammeter readings I_1``, $I_2$`` and I_3`` (Short circuit voltage source V_1 by connecting switch S_1 to 'b').
6. Switch ON the both voltage sources V1 and V2 and note down the corresponding ammeter readings I_1, I_2, and I_3
7. Algebraically add the currents in steps 4 and 5 above and compare with current in step 6 above to verify the theorem.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions to be followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

S. No	Observed									Calculated								
	Voltage source V1			Voltage source V2			Both Voltage source V1 & V2			Voltage source V1			Voltage source V2			Both Voltage source V1 & V2		
	I_1`	I_2`	I_3`	I_1``	I_2``	I_3``	I_1	I_2	I_3	I_1`	I_2`	I_3`	I_1``	I_2``	I_3``	I_1	I_2	I_3
1																		

Calculation:-

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1 State the limitation of superposition theorem

2 Can superposition theorem be applied to a circuit containing one AC and one DC source?

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the measuring instruments	10 %
2.	Identification of components	20 %
3.	Measuring value using suitable instrument	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculate theoretical values of given component	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 14: Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying thevenin's theorem

I Practical Significance

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The Electrical & Electronic circuit for different systems involves a number of branches. Many a times as per the requirement, measurement of current and voltage across a branch is required. These parameters of the circuit can be calculated using Thevenins theorem. This experiment will help you to verify the theoretically obtained current through a branch using Thevenin's theorem.

II Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.
Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.
Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.
Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

i. Measure electrical quantities.
ii. Follow safe practices

IV Relevant Course Outcome(s)

Apply network theorems to troubleshoot problems related to electric circuits.

V Practical Outcome

Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Thevenin's theorem.

VI Relevant Affective domain related Outcome(s)

Follow safety electrical rules for safe practices.

VII Minimum Theoretical Background

Statement of Thevenin's theorem: Any linear, bilateral electrical network having open terminals A & B (by removing load resistance) can be replaced by a single voltage source of V_{TH} in series with a single resistance R_{TH}. Where, V_{TH} is the voltage obtained across the open terminals A & B. The resistance R_{TH} is the equivalent resistance of the network measured between open terminals A & B, with all sources replaced by their internal resistances.

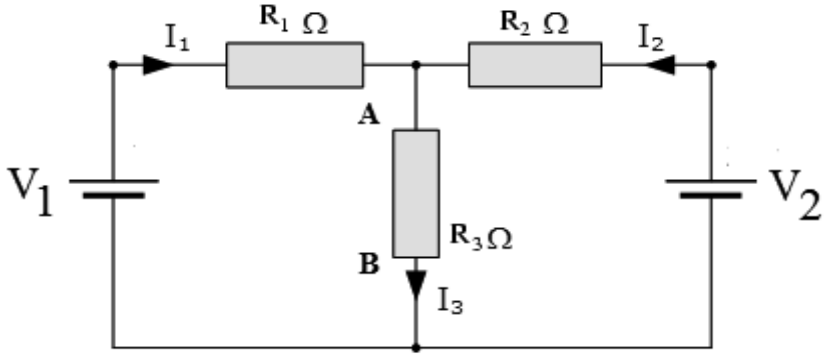

Figure 1

VIII Practical set-up / Circuit diagram / Work Situation

(Student should draw the circuit diagram and get it verified /checked from the concerned teacher.)

Find V_{TH}, across open terminals A and B

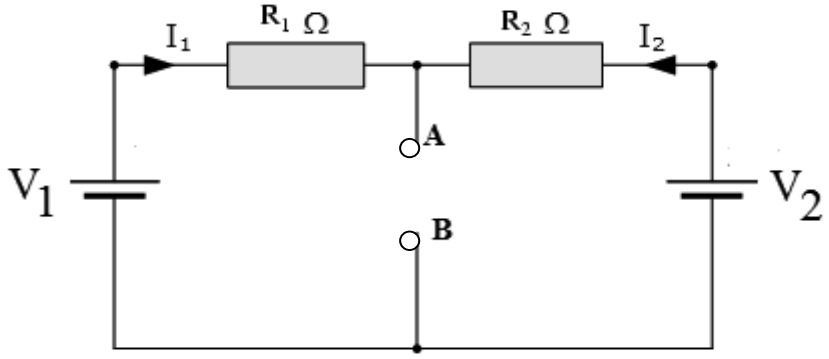

Figure 2

Find R_{TH} across terminals A & B

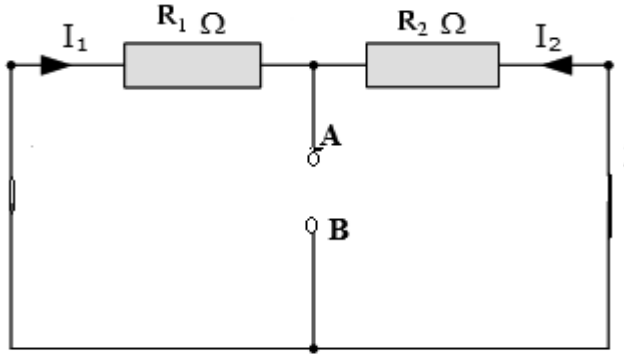

Figure 3

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Voltmeter	Suitable Voltmeters	1	
3	Rheostat	Suitable Rheostat	3	
4	Voltage Source	Suitable Voltage Sources	2	
5	Multimeter	Suitable Multimeter	1	

X Precautions

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.

XI Procedure

1. Connect the circuit as shown in circuit diagram.
2. Confirm all the meters should be at zero position.
3. Set the rheostat at suitable position.
4. Remove load resistance R3 through terminals A & B
5. Switch ON both voltage sources V_1 and V2 and note down the voltage across the open terminals A and B (i.e. V_{TH}). As shown in figure 2.
6. Remove both voltage sources by internal resistances or short circuits the terminal of it's and measure the resistance between open terminals A and B (i.e. R_{TH}). As shown in figure 3
7. Calculate the current in resistance R_3 by using observed V_{TH} and R_{TH}, $I_{R3} = V_{TH}/(R_{TH}+R_3)$.
8. Switch off the supply.
9. Verify theorem.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Qty	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Sr.no.	**Observed**			**Calculated**		
	V_{TH}	R_{TH}	$I_{R3} = V_{TH} / (R_{TH} + R_3)$	V_{TH}	R_{TH}	$I_{R3} = V_{TH} / (R_{TH} + R_3)$
1						
2						

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. State the necessity of Theorems in electrical circuit.
2. How will you overcome the problem of overload of DC power supply?
3. Can we perform the experiment with ac supply also? Justify

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the measuring instruments	10 %
2.	Identification of components and voltage sources	20 %
3.	Measuring value using suitable instrument	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculate theoretical values of given component	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……..…….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 15: Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying norton's theorem

I Practical Significance

The Electrical & Electronic circuit for different systems involves a number of branches. Many a times as per the requirement, measurement of current and voltage across a branch is required. These parameters of the circuit can be calculated using Norton's theorem. This experiment will help you to verify the theoretically obtained current through a branch using Norton's theorem.

II Relevant Program Outcomes

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.
Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.
Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.
Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

i. Measure electrical quantities.
ii. Follow safe practices

IV Relevant Course Outcome(s)

Apply network theorems for analysis and troubleshooting problems related to electric circuits.

V Practical Outcome

Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Norton's theorem.

VI Relevant Affective domain related Outcome(s)

Follow safety electrical rules for safe practices.

VII Minimum Theoretical Background :

Statement of Norton's theorem: Any linear bilateral network having two terminals A & B of load can be replaced by a current source of a current I_N in parallel with a resistance R_N. The current source I_N is equal to the current that would flow through AB when A & B are short circuited. The resistance R_N is the resistance of the network measured between A & B with load removed & the all sources are replaced by their internal resistances.

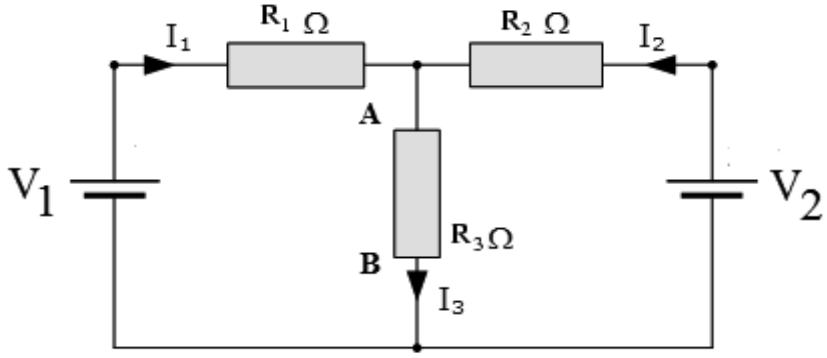

Figure 1

VIII Practical set-up / Circuit diagram / Work Situation

(Student should draw the circuit diagram and get it verified /checked from the concerned teacher.)

Measure I_N, in terminals A and B

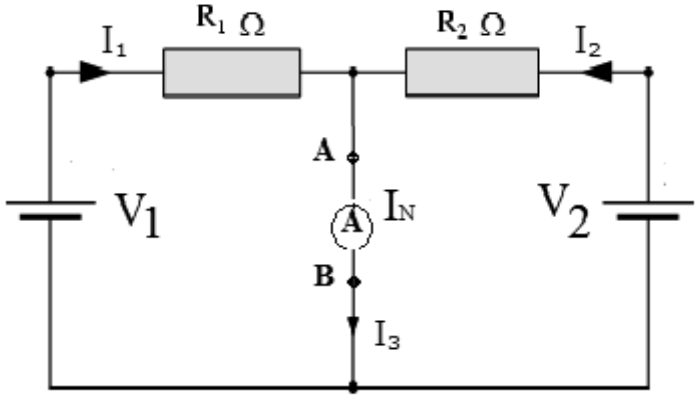

Figure 2

Find R_N across terminals A & B

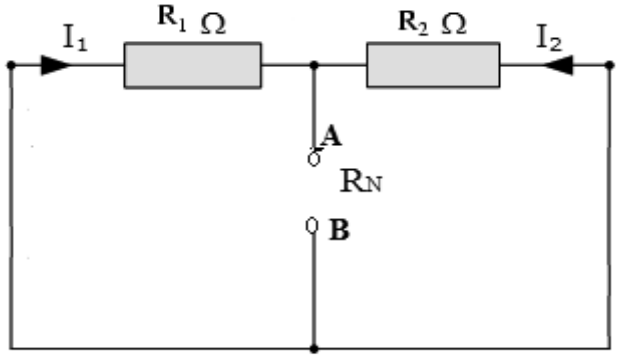

Figure 3

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Voltmeter	Suitable Voltmeters	1	
3	Rheostat	Suitable Rheostat	3	
4	Voltage Source	Suitable Voltage Sources	2	
5	Multimeter	Suitable Multimeter	1	
6	Ammeter	Suitable Ammeter	1	

X Precautions

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.

XI Procedure

1. Connect the circuit as shown in circuit diagram.
2. Confirm all the meters should be at zero position.
3. Set the rheostat at suitable position.
4. Connect the circuit as shown in circuit diagram of figure 2.
5. Remove load resistance R3 & short circuit terminals A & B through ammeter.
6. Switch ON both voltage sources V_1 and V2 and note down the current through the short terminals A and B (i.e.I_N). As shown in figure 2.
7. Remove both voltage sources by internal resistances or short circuits the terminal of it's and measure the resistance between open terminals A and B (i.e. R_N). As shown in figure 3
8. Calculate the current in resistance R_3 by using observed value of I_N and R_N. $I_L = I_3 = I_N \times R_N / (R_N + R_3)$.
9. Calculate the current in resistance R_3 by using Norton's theorem.
10. Switch off the supply.
11. Verify theorem.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Qty	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed

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Sr. no.	Observed			Calculated		
	I_N (amps)	R_N Ω	I_{R3} (amps)	I_N (amps)	R_N Ω	$I_{R3}= I_N * R_N / (R_3 + R_N)$ (amps)
1						
2						
3						

XV Observations and Calculations

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. State the necessity of Norton Theorems in electrical circuit.
2. Can we perform the experiment with ac supply also? Justify
3. For a network if $V_{TH}=5<0^o$ volts & $I_N=2< 30^{0,}$ what is the value of $Z_{TH.}$

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the measuring instruments	10 %
2.	Identification of components and voltage sources	20 %
3.	Measuring value using suitable instrument	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculate theoretical values of given component	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. ……..
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 16: Use voltmeter, ammeter to determine load resistance for maximum power transfer for a given circuit by applying maximum power transfer theorem.

I Practical Significance

In the industry environment Electrical Engineering diploma graduate are expected to understand various theorems. To interpret the application of maximum power transfer theorem. This practical will help you to acquire necessary knowledge of maximum power observed in the load and efficiency of the electrical circuit at maximum power transfer condition. To observe and record the readings and to calculate the load resistance at maximum power transfer condition

II Relevant Program Outcomes (POs)

Discipline knowledge: Apply Electrical engineering knowledge to solve broad based Electrical engineering related problems.

Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical engineering problems.

Engineering tools: Apply relevant Electrical engineering and tools with an understanding of the limitations.

Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electrical systems applying AC and DC circuit fundamentals'**:

i. Measure electrical quantities.
ii. Follow safe practices

IV Relevant Course Outcome(s)

Apply network theorems for analysis and troubleshoot problems related to electric circuits.

V Practical Outcome

Use voltmeter, ammeter to determine load resistance for maximum power transfer for a given circuit by applying maximum power transfer theorem.

VI Relevant Affective domain related Outcome(s)

Follow safety electrical rules for safe practices.

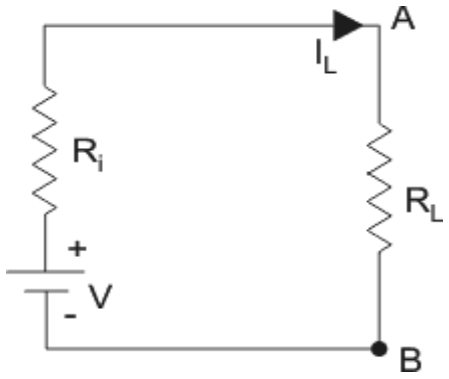
VII Minimum Theoretical Background

It states that, maximum power is absorbed by the load from the source when the load resistance (R_L) is equal to the internal resistance (R_i) of the source.

Power absorbed by the load (P_L) will be maximum when $R_i = R_L$

Total power Supplied by the Source $P = P_i + P_L$	Power loss in the internal resistance of source $P_i = I^2 * R_i$	Power absorbed by the load $P_L = I^2 * R_L$ (as $R_i = R_L$) i.e. efficiency = 50%

VIII Practical set-up / Circuit diagram / Work Situation



(Student should draw the circuit diagram and get it verified /checked from the concerned teacher.)

(Space for circuit diagram)

IX Resources Required

S. No.	Particulars	Specification	Quantity	Remark
1	Ammeter	Suitable Ammeters	1	
2	Voltmeter	Suitable Voltmeters	1	
3	Rheostat	Suitable Rheostat	2	

X Precautions

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.

XI Procedure

a) Make the connections as shown in circuit diagram.
b) Set the load rheostat for maximum resistance
c) Set the supply voltage to its rated value
d) Switch ON the supply.
e) Record the readings current and voltage across load by varying the load resistance R_L.
f) Perform the necessary calculations.
g) Plot the graph between load resistance R_L and powers absorbed by the load P_L and determine the value of load resistance for maximum power transfer from graph.
h) Take different readings without exceeding the current limits
i) Switch OFF the supply

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions to be followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Sr. No.	**Measured Values at R_i = ---**		**Calculated Values**	
	Current through load resistance	Voltage across load resistance	Load resistance $R_L=V_L/I_L$	Power absorbed by load resistance $P_L=I_L^2*R_L$
	I_L (Amp)	V_L (Volts)	Ohms	Watts
1				
2				
3				
4				
5				
6				
7				

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusion and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. Prove that the efficiency is 50% under maximum power transfer condition.
2. State the purpose and applications of maximum power transfer theorem.
3. Under what situation maximum power transfer theorem is not applicable? Give reasons.

[Space for Answers]

XX References / Suggestions for further reading

1. Laboratory Course in Electrical Engineering – Dr. S.G. Tarnekar and Shri. P.K. Kharbanda et. al. S.Chand and Co. Pvt. Ltd. New Delhi. ISBN no.: 81-219-0104-9
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XXI Suggested Assessment Scheme

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1.	Handling of the measuring instruments	10 %
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3.	Measuring value using suitable instrument	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculate theoretical values of given component	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……..
3. ……

Marks Obtained			**Dated signature of Teacher**
Process Related(15)	**Product Related(10)**	**Total (25)**	

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	'C' programming Language	22218
15	Basic Electronics	22225
16	Programming in "C"	22226
17	Fundamentals of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemicals	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurements	22420
12	Digital Electronics And Microcontroller Applications	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048

Fifth Semester:

1	Design of Steel and RCC Structures	22502
2	Public Health Engineering	22504
3	Heat Transfer Operation	22510
4	Environmental Technology	22511
5	Operating Systems	22516
6	Advanced Java Programming	22517
7	Software Testing	22518
8	Control Systems and PLC's	22531
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12	Switchgear and Protection	22524
13	Energy Conservation and Audit	22525
14	Power Engineering and Refrigeration	22562
15	Solid Modeling and Additive Manufacturing	22053
16	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22057

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
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16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
19	Advanced Communication System	17656
20	Mobile Communication	17657
21	Embedded System	17658
22	Process Control System	17663
23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

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