VOLTBOOK / GTU DIPLOMA ELECTRICAL

AC Fundamental

DETAILED OUTCOME-BASED PRACTICAL MANUAL

COURSE CODE	SEMESTER	PRACTICALS	EFFECTIVE FROM
DI02C00171	2	15	2024-25

Prepared from the Suggested Course Practical List in the current GTU DI-series syllabus, effective 2024-25.

The organization follows the familiar outcome-based pattern used in legacy DTE laboratory manuals. All instructional text is independently written for this edition. This is not an official GTU, DTE or CTE publication.

Student name: ____

Enrollment no.: ____________________ Batch: ________________

Institute: ____

UNIVERSITY-DRAFTED FIGURE EDITION 6.0 / 20 JULY 2026

Certificate

This is to certify that ____, enrollment number ____________________, has satisfactorily completed the prescribed practical work for AC Fundamental (DI02C00171) during the academic term ____________________ under the supervision of the department.

Laboratory faculty	Head of department	Principal
Signature and date	Signature and date	Signature and date

Preface

This manual turns the current syllabus practical list into a usable student record. Each practical includes an original experiment-specific vector diagram and is arranged from objective and outcomes through prerequisite theory, setup, resources, safety, procedure, observations, interpretation, questions, references and a 25-mark assessment rubric.

Students should complete pre-lab preparation before the session and record actual readings during the session. Faculty may adapt component values, instrument ranges, software versions and local assessment requirements without changing the intended practical outcome.

Diagram drafting benchmarks were reviewed from Aurora's Electrical Circuits and Simulation manual, MITS Electronic Devices and Circuits manual, Sree Vahini's Electrical Measurements manual, and MSBTE Electrical Estimating and Contracting practice. Edition 6.0 applies stricter university drafting: complete current paths, IEC-style junctions and terminals, protection, instrument coils, test points, load terminals and measurement notes. Every figure is newly drawn and aligned to the current GTU practical title.

Official syllabus reference

Open the referenced GTU syllabus PDF

Programme outcomes and course outcomes

Programme outcomes

Code	Outcome
PO1	Basic and discipline-specific knowledge: apply mathematics, science and engineering fundamentals.
PO2	Problem analysis: identify and analyze well-defined engineering problems using standard methods.
PO3	Design/development of solutions: develop solutions for well-defined technical problems.
PO4	Engineering tools, experimentation and testing: use modern tools and interpret test results.
PO5	Engineering practices for society, sustainability and environment: apply safe and responsible practice.
PO6	Project management: apply engineering management principles individually and in teams.
PO7	Lifelong learning: recognize the need for independent learning in changing technology.

Course competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

Course outcomes

CO	Course outcome
CO1	Interpret AC terminology, waveforms and vector representation.
CO2	Apply the principles of AC series circuits.
CO3	Apply the principles of AC parallel circuits.
CO4	Apply the principles of balanced three-phase systems.

Practical outcome to course outcome matrix

The mapping below is for learning guidance. Faculty should use the assessment scheme prescribed by the institute.

No.	Suggested practical	Mapped CO
1	Demonstrate waveforms of alternating quantities using CRO and function generator	CO1
2	Use CRO to measure peak value, RMS value, time period and frequency	CO1
3	Measure voltage, current and power through a pure resistor	CO2
4	Measure inductance and internal resistance of a choke coil	CO2
5	Measure voltage, current, power and power factor in an RL series circuit	CO2
6	Measure voltage, current, power and power factor in an RC series circuit	CO2
7	Measure voltage, current, power and power factor in an RLC series circuit	CO2
8	Measure resonant frequency and resonant impedance in an RLC series circuit	CO2
9	Measure voltage, current, power and power factor in an RL parallel circuit	CO3
10	Measure voltage, current, power and power factor in an RC parallel circuit	CO3
11	Measure voltage, current, power and power factor in an RLC parallel circuit	CO3
12	Verify line and phase voltage/current relations for three-phase star connection	CO4
13	Verify line and phase voltage/current relations for three-phase delta connection	CO4
14	Measure voltage, current, power and power factor in three-phase circuits	CO4
15	Test the relation between power consumption in star and delta connected loads	CO4

Industry skills and laboratory guidance

Industry-relevant skills

- Safe operation of isolated AC trainers
- RMS, frequency and phase measurement
- Power and power-factor calculation
- Phasor-based interpretation of AC circuits

Guidelines for instructors

1. Confirm the practical outcome, risk controls, apparatus readiness and emergency arrangements before the session.
2. Demonstrate only the critical connection, software or measurement steps; require students to reason through the remaining work.
3. Check circuit polarity, earthing, isolation, ranges and ratings before energization.
4. Assess both process and result. Give credit for safe practice, honest data, teamwork and technically sound interpretation.
5. Adapt values and equipment to local facilities while preserving the mapped course outcome.

Instructions for students

1. Read the practical, write the prediction and prepare the setup before entering the laboratory.
2. Record instrument identification, range, least count and component ratings before use.
3. Enter raw readings directly with units. Strike through errors once; do not erase or fabricate data.
4. Switch OFF and verify isolation before changing a connection. Report damage, heating, smell or unstable readings immediately.
5. Attach graphs, code listings, drawings, estimates and technical evidence behind the relevant practical.

Progressive assessment rubric

Each practical is assessed out of 25 marks. The practical-specific rubric repeats at the end of every experiment.

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Suggested interpretation

Total	Level	Interpretation
21-25	Excellent	Independent, accurate, safe and well interpreted
16-20	Good	Sound performance with minor correction
11-15	Satisfactory	Outcome achieved with guidance
0-10	Needs improvement	Repeat preparation or practical work as directed

Safety acknowledgement

I understand that institute rules and faculty instructions take priority over this manual. I will not energize, modify or touch a circuit without authorization.

Student signature and date	Faculty signature and date

Continuous assessment record

Practical	Date	Marks /25	Faculty initials
01			
02			
03			
04			
05			
06			
07			
08			
09			
10			
11			
12			
13			
14			
15			
TOTAL		/375	

Experiment index

PRACTICAL 01

Demonstrate waveforms of alternating quantities using CRO and function generator

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Demonstrate waveforms of alternating quantities using CRO and function generator.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO1: Interpret AC terminology, waveforms and vector representation.

E. Practical learning outcomes

1. Identify construction, rating, operating principle and application of the item or system.
2. Record observations in a labelled diagram and comparative technical table.
3. Form a justified conclusion using verified technical evidence.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

This is an identification and engineering-observation exercise. Record construction, ratings, operating principle, application, limitations and safety requirements for every item or system studied. Use nameplate data and current manufacturer or utility information; clearly distinguish observation from inference.

Key relations / checks

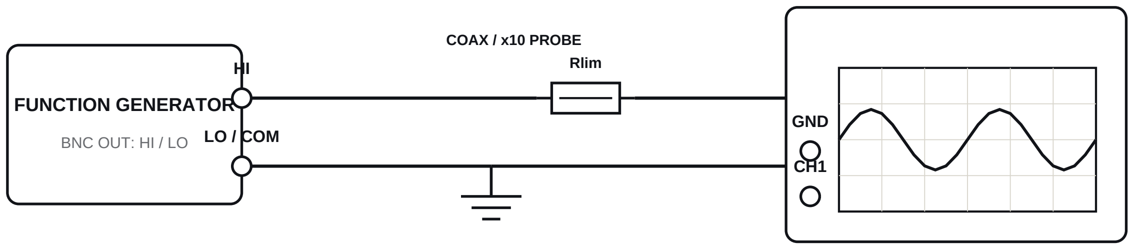
- Vpeak = vertical divisions x volts/division
- T = horizontal divisions x time/division
- f = 1/T
- For a sine wave Vrms = Vpeak/sqrt(2)

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.1 - FUNCTION-GENERATOR WAVEFORM DISPLAY ON CRO/DSO

VERIFY VALUES BEFORE USE



Set probe factor, coupling and trigger before taking readings

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Function generator	Sine/triangle/square; laboratory bandwidth	1
CRO / DSO	Two channel; suitable bandwidth	1
Oscilloscope probe	x1/x10, compensated	1
BNC leads / test leads	Screened and inspected	1 set
Reference resistor	Current limiting; instructor selected	1

J. Safety and precautions

1. Use only the instructor-approved isolated function-generator output.
2. Never connect a bench-oscilloscope ground clip to an unknown or live mains-referenced point.
3. Match probe attenuation and instrument setting before measuring.
4. Change BNC/probe connections only with the source output disabled.

K. Procedure

1. Keep both instruments OFF. Connect function-generator HI to CRO/DSO CH1 through the approved probe and connect LO/COM to the common reference exactly as shown.
2. Set the probe attenuation on the probe and instrument to the same value; select DC coupling, a centered trace and a safe initial volts/div setting.
3. Set a low-amplitude sine wave on the function generator, switch ON, and adjust trigger source, level and time/div until a stationary waveform is obtained.
4. Display sine, square and triangular waveforms in turn and sketch each waveform with its generator settings.
5. For one waveform, count vertical and horizontal divisions and verify amplitude and frequency against the generator display.
6. Repeat with a second amplitude and frequency without exceeding the instrument or probe rating; record the scale settings with every reading.
7. Return amplitude to minimum, switch OFF, remove the probe by its connector and state the measured result with percentage difference.

L. Observations and calculations

Record verified ratings and constructional observations. Identify the source of any information not obtained directly from the sample or site.

Item / parameter	Rating / value	Construction / principle	Application	Remarks

LABELLED SKETCH / SINGLE-LINE DIAGRAM / COMPARATIVE NOTES

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Demonstrate waveforms of alternating quantities using CRO and function generator'? Answer: ______________________________
2	How are real, reactive and apparent power related in this circuit? Answer: ______________________________
3	What causes the phase difference between voltage and current? Answer: ______________________________
4	What safety step must be completed before changing a connection or configuration? Answer: ______________________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 02

Use CRO to measure peak value, RMS value, time period and frequency

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Use CRO to measure peak value, RMS value, time period and frequency.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO1: Interpret AC terminology, waveforms and vector representation.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

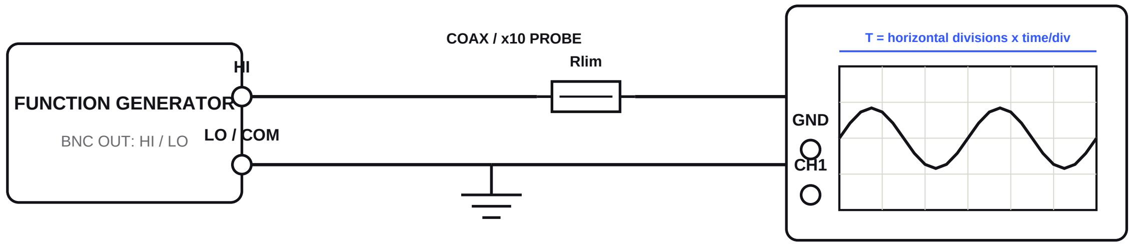
Key relations / checks

- Vpeak = vertical divisions x volts/division
- T = horizontal divisions x time/division
- f = 1/T
- For a sine wave Vrms = Vpeak/sqrt(2)

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.2 - CRO/DSO CONNECTION AND GRATICULE MEASUREMENT VERIFY VALUES BEFORE USE



Set probe factor, coupling and trigger before taking readings

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Function generator	Sine/triangle/square; laboratory bandwidth	1
CRO / DSO	Two channel; suitable bandwidth	1
Oscilloscope probe	x1/x10, compensated	1
BNC leads / test leads	Screened and inspected	1 set
Reference resistor	Current limiting; instructor selected	1

J. Safety and precautions

1. Use only the instructor-approved isolated function-generator output.
2. Never connect a bench-oscilloscope ground clip to an unknown or live mains-referenced point.
3. Match probe attenuation and instrument setting before measuring.
4. Change BNC/probe connections only with the source output disabled.

K. Procedure

1. Keep both instruments OFF. Connect function-generator HI to CRO/DSO CH1 through the approved probe and connect LO/COM to the common reference exactly as shown.
2. Set the probe attenuation on the probe and instrument to the same value; select DC coupling, a centered trace and a safe initial volts/div setting.
3. Set a low-amplitude sine wave on the function generator, switch ON, and adjust trigger source, level and time/div until a stationary waveform is obtained.
4. Count vertical divisions from the reference line to the peak and calculate Vp; obtain Vpp and Vrms for the sine wave.
5. Measure one complete cycle in horizontal divisions, calculate T from time/div, and calculate f = 1/T.
6. Repeat with a second amplitude and frequency without exceeding the instrument or probe rating; record the scale settings with every reading.
7. Return amplitude to minimum, switch OFF, remove the probe by its connector and state the measured result with percentage difference.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Applied value	Measured value 1	Measured value 2	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Use CRO to measure peak value, RMS value, time period and frequency'? Answer: ________________
2	How are real, reactive and apparent power related in this circuit? Answer: ________________
3	What causes the phase difference between voltage and current? Answer: ________________
4	What safety step must be completed before changing a connection or configuration? Answer: ________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 03

Measure voltage, current and power through a pure resistor

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure voltage, current and power through a pure resistor.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO2: Apply the principles of AC series circuits.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

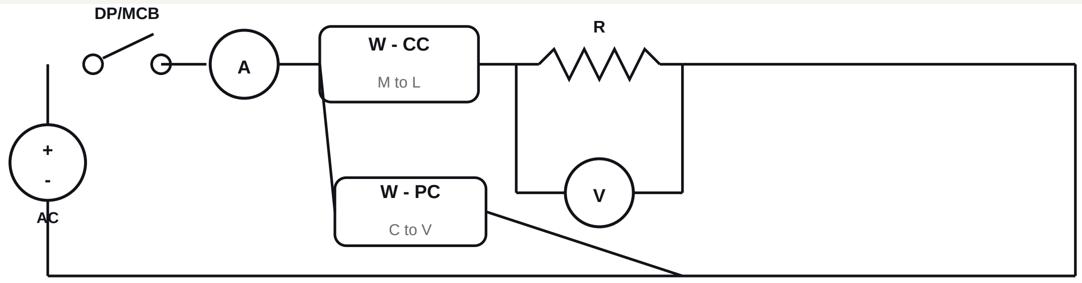
Key relations / checks

- State the governing relation before substitution
- Use consistent SI units
- % difference = |observed - expected|/expected x 100

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.3 - PURE-RESISTIVE AC LOAD MEASUREMENT VERIFY VALUES BEFORE USE



Record V, I and W; calculate Z and power factor

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Isolated AC source / variac	Instructor-controlled	1
Load / trainer	R, L and C as required	1 set
True-RMS meters	Suitable CAT and ranges	1 set
Wattmeter / analyzer	Suitable rating	1
Leads and PPE	Inspected and approved	1 set

J. Safety and precautions

1. Do not energize or alter a circuit without instructor approval.
2. Use intact leads, correct instrument ranges, rated components and required PPE.
3. Switch OFF, isolate and verify absence of voltage before touching conductors.
4. Work on 230/415 V equipment only on an approved isolated trainer under direct supervision.

K. Procedure

1. Study the circuit or connection diagram, predict the expected result, and select instruments with suitable ranges.
2. Keep the supply OFF. Inspect leads and components, set controls to minimum, and make the circuit exactly as shown.
3. Ask the instructor to verify connections, polarity, earthing, instrument range and component ratings before energizing.
4. Switch ON using an isolated/current-limited source. Increase the input gradually and watch for abnormal heating or readings.
5. Take at least five sets of stable readings over the safe operating range and record units immediately.
6. Switch OFF before changing any connection. Repeat only the approved changes required by the experiment.
7. Calculate theoretical values and percentage error, plot the required characteristic where applicable, and state the result.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Applied value	Measured value 1	Measured value 2	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Measure voltage, current and power through a pure resistor'? Answer: ________________
2	How are real, reactive and apparent power related in this circuit? Answer: ________________
3	What causes the phase difference between voltage and current? Answer: ________________
4	What safety step must be completed before changing a connection or configuration? Answer: ________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 04

Measure inductance and internal resistance of a choke coil

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure inductance and internal resistance of a choke coil.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO2: Apply the principles of AC series circuits.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

Key relations / checks

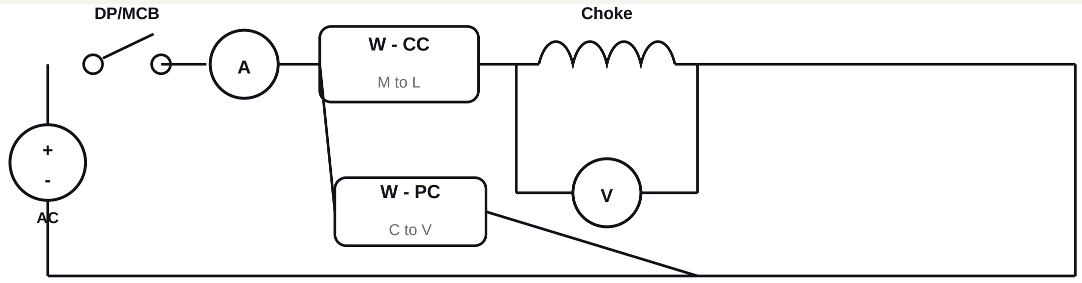
- V = I R
- P = V I = I^2 R = V^2/R
- % error = |measured - calculated| / calculated x 100

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.4 - CHOKE-COIL INDUCTANCE AND RESISTANCE TEST

VERIFY VALUES BEFORE USE



Record V, I and W; calculate Z and power factor

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Isolated AC source / variac	Instructor-controlled	1
Load / trainer	R, L and C as required	1 set
True-RMS meters	Suitable CAT and ranges	1 set
Wattmeter / analyzer	Suitable rating	1
Leads and PPE	Inspected and approved	1 set

J. Safety and precautions

1. Do not energize or alter a circuit without instructor approval.
2. Use intact leads, correct instrument ranges, rated components and required PPE.
3. Switch OFF, isolate and verify absence of voltage before touching conductors.
4. Work on 230/415 V equipment only on an approved isolated trainer under direct supervision.

K. Procedure

1. Study the circuit or connection diagram, predict the expected result, and select instruments with suitable ranges.
2. Keep the supply OFF. Inspect leads and components, set controls to minimum, and make the circuit exactly as shown.
3. Ask the instructor to verify connections, polarity, earthing, instrument range and component ratings before energizing.
4. Switch ON using an isolated/current-limited source. Increase the input gradually and watch for abnormal heating or readings.
5. Take at least five sets of stable readings over the safe operating range and record units immediately.
6. Switch OFF before changing any connection. Repeat only the approved changes required by the experiment.
7. Calculate theoretical values and percentage error, plot the required characteristic where applicable, and state the result.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Applied value	Measured value 1	Measured value 2	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Measure inductance and internal resistance of a choke coil'? Answer: ______________________________
2	How are real, reactive and apparent power related in this circuit? Answer: ______________________________
3	What causes the phase difference between voltage and current? Answer: ______________________________
4	What safety step must be completed before changing a connection or configuration? Answer: ______________________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 05

Measure voltage, current, power and power factor in an RL series circuit

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure voltage, current, power and power factor in an RL series circuit.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO2: Apply the principles of AC series circuits.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

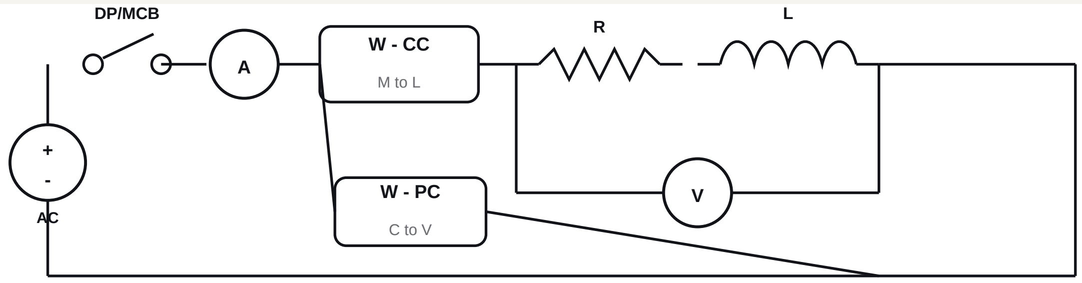
Key relations / checks

- Z = R + j(XL - XC)
- I = V/|Z|
- cos(phi) = P/(V I)
- At series resonance XL = XC

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.5 - AC SERIES CIRCUIT WITH WATTMETER AND VOLTAGE MEASUREMENTS VERIFY VALUES BEFORE USE



Record V, I and W; calculate Z and power factor

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Isolated AC source / variac	Instructor-controlled	1
Load / trainer	R, L and C as required	1 set
True-RMS meters	Suitable CAT and ranges	1 set
Wattmeter / analyzer	Suitable rating	1
Leads and PPE	Inspected and approved	1 set

J. Safety and precautions

1. Do not energize or alter a circuit without instructor approval.
2. Use intact leads, correct instrument ranges, rated components and required PPE.
3. Switch OFF, isolate and verify absence of voltage before touching conductors.
4. Work on 230/415 V equipment only on an approved isolated trainer under direct supervision.

K. Procedure

1. Study the circuit or connection diagram, predict the expected result, and select instruments with suitable ranges.
2. Keep the supply OFF. Inspect leads and components, set controls to minimum, and make the circuit exactly as shown.
3. Ask the instructor to verify connections, polarity, earthing, instrument range and component ratings before energizing.
4. Switch ON using an isolated/current-limited source. Increase the input gradually and watch for abnormal heating or readings.
5. Take at least five sets of stable readings over the safe operating range and record units immediately.
6. Switch OFF before changing any connection. Repeat only the approved changes required by the experiment.
7. Calculate theoretical values and percentage error, plot the required characteristic where applicable, and state the result.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Applied value	Measured value 1	Measured value 2	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Measure voltage, current, power and power factor in an RL series circuit'? Answer: ________________________________
2	How are real, reactive and apparent power related in this circuit? Answer: ________________________________
3	What causes the phase difference between voltage and current? Answer: ________________________________
4	What safety step must be completed before changing a connection or configuration? Answer: ________________________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 06

Measure voltage, current, power and power factor in an RC series circuit

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure voltage, current, power and power factor in an RC series circuit.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO2: Apply the principles of AC series circuits.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

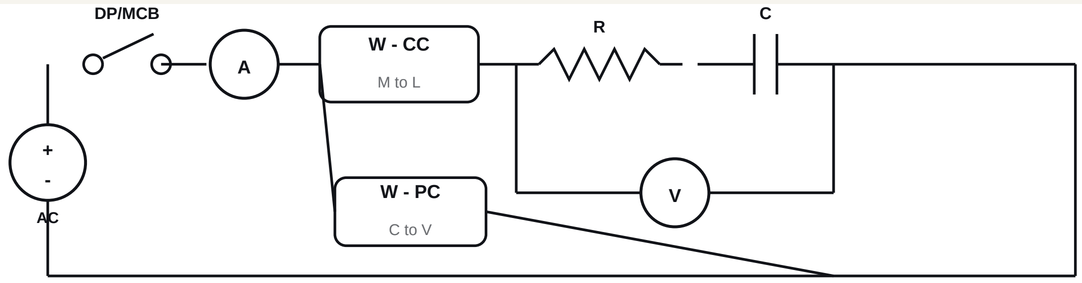
Key relations / checks

- Z = R + j(XL - XC)
- I = V/|Z|
- cos(phi) = P/(V I)
- At series resonance XL = XC

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.6 - AC SERIES CIRCUIT WITH WATTMETER AND VOLTAGE MEASUREMENTS VERIFY VALUES BEFORE USE



Record V, I and W; calculate Z and power factor

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Isolated AC source / variac	Instructor-controlled	1
Load / trainer	R, L and C as required	1 set
True-RMS meters	Suitable CAT and ranges	1 set
Wattmeter / analyzer	Suitable rating	1
Leads and PPE	Inspected and approved	1 set

J. Safety and precautions

1. Do not energize or alter a circuit without instructor approval.
2. Use intact leads, correct instrument ranges, rated components and required PPE.
3. Switch OFF, isolate and verify absence of voltage before touching conductors.
4. Work on 230/415 V equipment only on an approved isolated trainer under direct supervision.

K. Procedure

1. Study the circuit or connection diagram, predict the expected result, and select instruments with suitable ranges.
2. Keep the supply OFF. Inspect leads and components, set controls to minimum, and make the circuit exactly as shown.
3. Ask the instructor to verify connections, polarity, earthing, instrument range and component ratings before energizing.
4. Switch ON using an isolated/current-limited source. Increase the input gradually and watch for abnormal heating or readings.
5. Take at least five sets of stable readings over the safe operating range and record units immediately.
6. Switch OFF before changing any connection. Repeat only the approved changes required by the experiment.
7. Calculate theoretical values and percentage error, plot the required characteristic where applicable, and state the result.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Applied value	Measured value 1	Measured value 2	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Measure voltage, current, power and power factor in an RC series circuit'? Answer: ____________________
2	How are real, reactive and apparent power related in this circuit? Answer: ____________________
3	What causes the phase difference between voltage and current? Answer: ____________________
4	What safety step must be completed before changing a connection or configuration? Answer: ____________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 07

Measure voltage, current, power and power factor in an RLC series circuit

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure voltage, current, power and power factor in an RLC series circuit.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO2: Apply the principles of AC series circuits.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

Key relations / checks

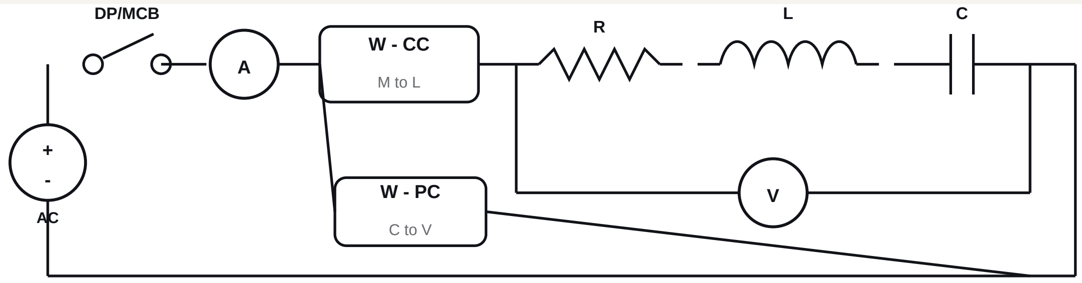
- Z = R + j(XL - XC)
- I = V/|Z|
- cos(phi) = P/(V I)
- At series resonance XL = XC

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.7 - AC SERIES CIRCUIT WITH WATTMETER AND VOLTAGE MEASUREMENTS

VERIFY VALUES BEFORE USE



Record V, I and W; calculate Z and power factor

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Isolated AC source / variac	Instructor-controlled	1
Load / trainer	R, L and C as required	1 set
True-RMS meters	Suitable CAT and ranges	1 set
Wattmeter / analyzer	Suitable rating	1
Leads and PPE	Inspected and approved	1 set

J. Safety and precautions

1. Do not energize or alter a circuit without instructor approval.
2. Use intact leads, correct instrument ranges, rated components and required PPE.
3. Switch OFF, isolate and verify absence of voltage before touching conductors.
4. Work on 230/415 V equipment only on an approved isolated trainer under direct supervision.

K. Procedure

1. Study the circuit or connection diagram, predict the expected result, and select instruments with suitable ranges.
2. Keep the supply OFF. Inspect leads and components, set controls to minimum, and make the circuit exactly as shown.
3. Ask the instructor to verify connections, polarity, earthing, instrument range and component ratings before energizing.
4. Switch ON using an isolated/current-limited source. Increase the input gradually and watch for abnormal heating or readings.
5. Take at least five sets of stable readings over the safe operating range and record units immediately.
6. Switch OFF before changing any connection. Repeat only the approved changes required by the experiment.
7. Calculate theoretical values and percentage error, plot the required characteristic where applicable, and state the result.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Applied value	Measured value 1	Measured value 2	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Measure voltage, current, power and power factor in an RLC series circuit'? Answer: ____________________
2	How are real, reactive and apparent power related in this circuit? Answer: ____________________
3	What causes the phase difference between voltage and current? Answer: ____________________
4	What safety step must be completed before changing a connection or configuration? Answer: ____________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 08

Measure resonant frequency and resonant impedance in an RLC series circuit

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure resonant frequency and resonant impedance in an RLC series circuit.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO2: Apply the principles of AC series circuits.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

Key relations / checks

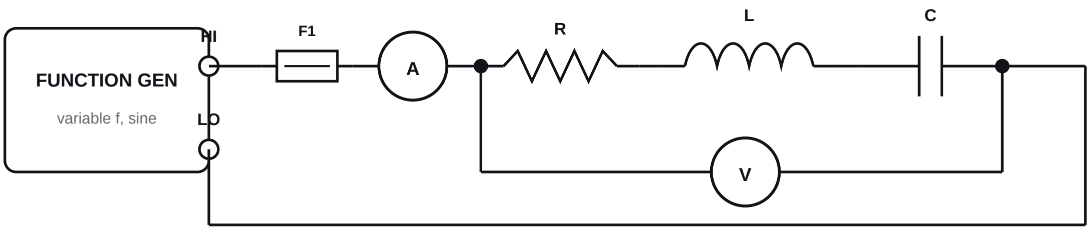
- Vpeak = vertical divisions x volts/division
- T = horizontal divisions x time/division
- f = 1/T
- For a sine wave Vrms = Vpeak/sqrt(2)

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.8 - SERIES RLC RESONANCE TEST WITH VARIABLE-FREQUENCY AC SOURCE

VERIFY VALUES BEFORE USE



Sweep f in small steps; resonance occurs at maximum I and minimum Z

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Isolated AC source / variac	Instructor-controlled	1
Load / trainer	R, L and C as required	1 set
True-RMS meters	Suitable CAT and ranges	1 set
Wattmeter / analyzer	Suitable rating	1
Leads and PPE	Inspected and approved	1 set

J. Safety and precautions

1. Do not energize or alter a circuit without instructor approval.
2. Use intact leads, correct instrument ranges, rated components and required PPE.
3. Switch OFF, isolate and verify absence of voltage before touching conductors.
4. Work on 230/415 V equipment only on an approved isolated trainer under direct supervision.

K. Procedure

1. Study the circuit or connection diagram, predict the expected result, and select instruments with suitable ranges.
2. Keep the supply OFF. Inspect leads and components, set controls to minimum, and make the circuit exactly as shown.
3. Ask the instructor to verify connections, polarity, earthing, instrument range and component ratings before energizing.
4. Switch ON using an isolated/current-limited source. Increase the input gradually and watch for abnormal heating or readings.
5. Take at least five sets of stable readings over the safe operating range and record units immediately.
6. Switch OFF before changing any connection. Repeat only the approved changes required by the experiment.
7. Calculate theoretical values and percentage error, plot the required characteristic where applicable, and state the result.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Applied value	Measured value 1	Measured value 2	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Measure resonant frequency and resonant impedance in an RLC series circuit'? Answer: ____________________
2	How are real, reactive and apparent power related in this circuit? Answer: ____________________
3	What causes the phase difference between voltage and current? Answer: ____________________
4	What safety step must be completed before changing a connection or configuration? Answer: ____________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 09

Measure voltage, current, power and power factor in an RL parallel circuit

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure voltage, current, power and power factor in an RL parallel circuit.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO3: Apply the principles of AC parallel circuits.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

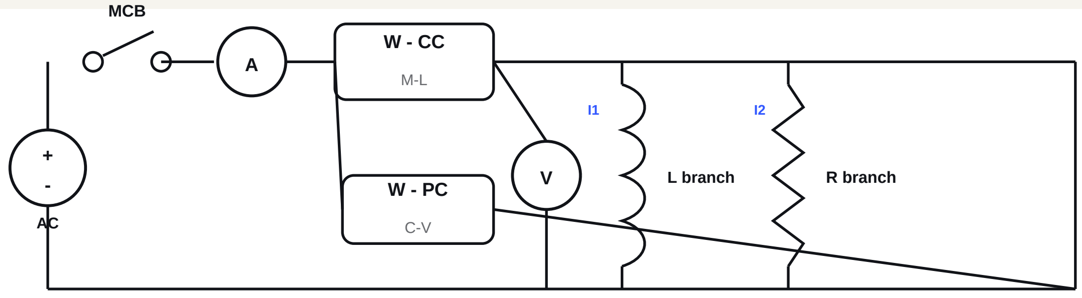
Key relations / checks

- Total current is the phasor sum of branch currents
- Admittance Y = G + jB
- cos(phi) = P/(V I)

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.9 - AC PARALLEL CIRCUIT WITH WATTMETER AND BRANCH MEASUREMENTS VERIFY VALUES BEFORE USE



Measure total and branch currents; verify phasor sum and P = VI cos(phi)

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Isolated AC source / variac	Instructor-controlled	1
Load / trainer	R, L and C as required	1 set
True-RMS meters	Suitable CAT and ranges	1 set
Wattmeter / analyzer	Suitable rating	1
Leads and PPE	Inspected and approved	1 set

J. Safety and precautions

1. Do not energize or alter a circuit without instructor approval.
2. Use intact leads, correct instrument ranges, rated components and required PPE.
3. Switch OFF, isolate and verify absence of voltage before touching conductors.
4. Work on 230/415 V equipment only on an approved isolated trainer under direct supervision.

K. Procedure

1. Study the circuit or connection diagram, predict the expected result, and select instruments with suitable ranges.
2. Keep the supply OFF. Inspect leads and components, set controls to minimum, and make the circuit exactly as shown.
3. Ask the instructor to verify connections, polarity, earthing, instrument range and component ratings before energizing.
4. Switch ON using an isolated/current-limited source. Increase the input gradually and watch for abnormal heating or readings.
5. Take at least five sets of stable readings over the safe operating range and record units immediately.
6. Switch OFF before changing any connection. Repeat only the approved changes required by the experiment.
7. Calculate theoretical values and percentage error, plot the required characteristic where applicable, and state the result.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Applied value	Measured value 1	Measured value 2	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Measure voltage, current, power and power factor in an RL parallel circuit'? Answer: ______________________
2	How are real, reactive and apparent power related in this circuit? Answer: ______________________
3	What causes the phase difference between voltage and current? Answer: ______________________
4	What safety step must be completed before changing a connection or configuration? Answer: ______________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 10

Measure voltage, current, power and power factor in an RC parallel circuit

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure voltage, current, power and power factor in an RC parallel circuit.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO3: Apply the principles of AC parallel circuits.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

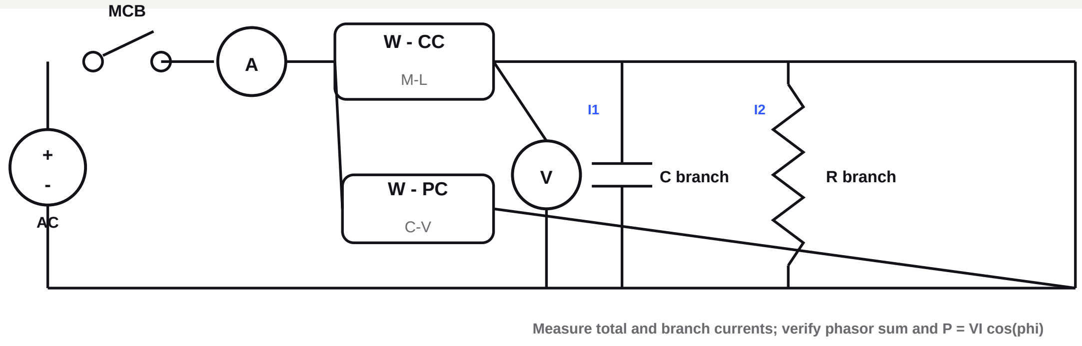
Key relations / checks

- Total current is the phasor sum of branch currents
- Admittance Y = G + jB
- cos(phi) = P/(V I)

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.10 - AC PARALLEL CIRCUIT WITH WATTMETER AND BRANCH MEASUREMENTS VERIFY VALUES BEFORE USE



Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Isolated AC source / variac	Instructor-controlled	1
Load / trainer	R, L and C as required	1 set
True-RMS meters	Suitable CAT and ranges	1 set
Wattmeter / analyzer	Suitable rating	1
Leads and PPE	Inspected and approved	1 set

J. Safety and precautions

1. Do not energize or alter a circuit without instructor approval.
2. Use intact leads, correct instrument ranges, rated components and required PPE.
3. Switch OFF, isolate and verify absence of voltage before touching conductors.
4. Work on 230/415 V equipment only on an approved isolated trainer under direct supervision.

K. Procedure

1. Study the circuit or connection diagram, predict the expected result, and select instruments with suitable ranges.
2. Keep the supply OFF. Inspect leads and components, set controls to minimum, and make the circuit exactly as shown.
3. Ask the instructor to verify connections, polarity, earthing, instrument range and component ratings before energizing.
4. Switch ON using an isolated/current-limited source. Increase the input gradually and watch for abnormal heating or readings.
5. Take at least five sets of stable readings over the safe operating range and record units immediately.
6. Switch OFF before changing any connection. Repeat only the approved changes required by the experiment.
7. Calculate theoretical values and percentage error, plot the required characteristic where applicable, and state the result.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Applied value	Measured value 1	Measured value 2	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Measure voltage, current, power and power factor in an RC parallel circuit'? Answer: ________________
2	How are real, reactive and apparent power related in this circuit? Answer: ________________
3	What causes the phase difference between voltage and current? Answer: ________________
4	What safety step must be completed before changing a connection or configuration? Answer: ________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 11

Measure voltage, current, power and power factor in an RLC parallel circuit

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure voltage, current, power and power factor in an RLC parallel circuit.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO3: Apply the principles of AC parallel circuits.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

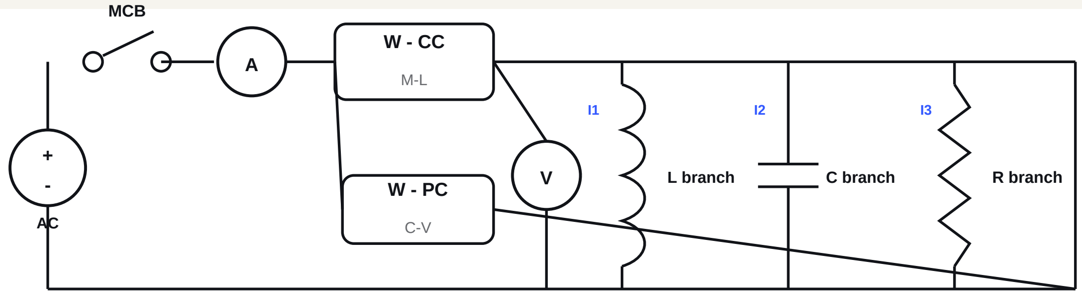
Key relations / checks

- Total current is the phasor sum of branch currents
- Admittance Y = G + jB
- cos(phi) = P/(V I)

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.11 - AC PARALLEL CIRCUIT WITH WATTMETER AND BRANCH MEASUREMENTS VERIFY VALUES BEFORE USE



Measure total and branch currents; verify phasor sum and P = VI cos(phi)

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Isolated AC source / variac	Instructor-controlled	1
Load / trainer	R, L and C as required	1 set
True-RMS meters	Suitable CAT and ranges	1 set
Wattmeter / analyzer	Suitable rating	1
Leads and PPE	Inspected and approved	1 set

J. Safety and precautions

1. Do not energize or alter a circuit without instructor approval.
2. Use intact leads, correct instrument ranges, rated components and required PPE.
3. Switch OFF, isolate and verify absence of voltage before touching conductors.
4. Work on 230/415 V equipment only on an approved isolated trainer under direct supervision.

K. Procedure

1. Study the circuit or connection diagram, predict the expected result, and select instruments with suitable ranges.
2. Keep the supply OFF. Inspect leads and components, set controls to minimum, and make the circuit exactly as shown.
3. Ask the instructor to verify connections, polarity, earthing, instrument range and component ratings before energizing.
4. Switch ON using an isolated/current-limited source. Increase the input gradually and watch for abnormal heating or readings.
5. Take at least five sets of stable readings over the safe operating range and record units immediately.
6. Switch OFF before changing any connection. Repeat only the approved changes required by the experiment.
7. Calculate theoretical values and percentage error, plot the required characteristic where applicable, and state the result.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Applied value	Measured value 1	Measured value 2	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Measure voltage, current, power and power factor in an RLC parallel circuit'? Answer: ____________
2	How are real, reactive and apparent power related in this circuit? Answer: ____________
3	What causes the phase difference between voltage and current? Answer: ____________
4	What safety step must be completed before changing a connection or configuration? Answer: ____________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 12

Verify line and phase voltage/current relations for three-phase star connection

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Verify line and phase voltage/current relations for three-phase star connection.

B. Expected programme outcomes

PO1, PO2, PO4, PO5, PO6.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO4: Apply the principles of balanced three-phase systems.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

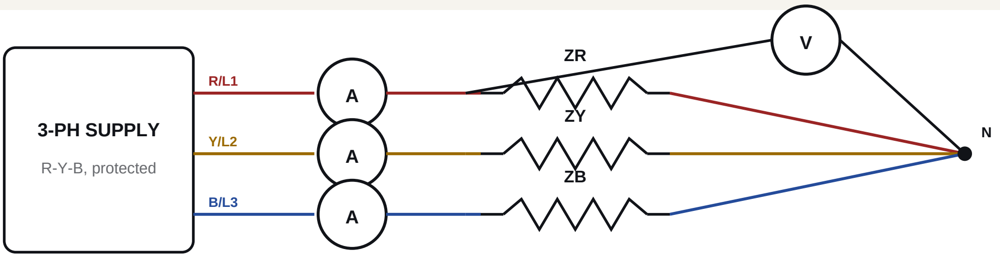
Key relations / checks

- Star: VL = sqrt(3) Vph and IL = Iph
- Delta: VL = Vph and IL = sqrt(3) Iph
- Balanced power P = sqrt(3) VL IL cos(phi)

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.12 - THREE-PHASE STAR LOAD: LINE/PHASE VOLTAGE AND CURRENT MEASUREMENT VERIFY VALUES BEFORE USE



Measure VL, Vph and IL; for balanced star VL = sqrt(3) Vph

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Isolated AC source / variac	Instructor-controlled	1
Load / trainer	R, L and C as required	1 set
True-RMS meters	Suitable CAT and ranges	1 set
Wattmeter / analyzer	Suitable rating	1
Leads and PPE	Inspected and approved	1 set

J. Safety and precautions

1. Do not energize or alter a circuit without instructor approval.
2. Use intact leads, correct instrument ranges, rated components and required PPE.
3. Switch OFF, isolate and verify absence of voltage before touching conductors.
4. Work on 230/415 V equipment only on an approved isolated trainer under direct supervision.

K. Procedure

1. Study the circuit or connection diagram, predict the expected result, and select instruments with suitable ranges.
2. Keep the supply OFF. Inspect leads and components, set controls to minimum, and make the circuit exactly as shown.
3. Ask the instructor to verify connections, polarity, earthing, instrument range and component ratings before energizing.
4. Switch ON using an isolated/current-limited source. Increase the input gradually and watch for abnormal heating or readings.
5. Take at least five sets of stable readings over the safe operating range and record units immediately.
6. Switch OFF before changing any connection. Repeat only the approved changes required by the experiment.
7. Calculate theoretical values and percentage error, plot the required characteristic where applicable, and state the result.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Line voltage	Line current	Power reading(s)	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Verify line and phase voltage/current relations for three-phase star connection'? Answer: ________________
2	How are real, reactive and apparent power related in this circuit? Answer: ________________
3	What causes the phase difference between voltage and current? Answer: ________________
4	What safety step must be completed before changing a connection or configuration? Answer: ________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 13

Verify line and phase voltage/current relations for three-phase delta connection

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Verify line and phase voltage/current relations for three-phase delta connection.

B. Expected programme outcomes

PO1, PO2, PO4, PO5, PO6.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO4: Apply the principles of balanced three-phase systems.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

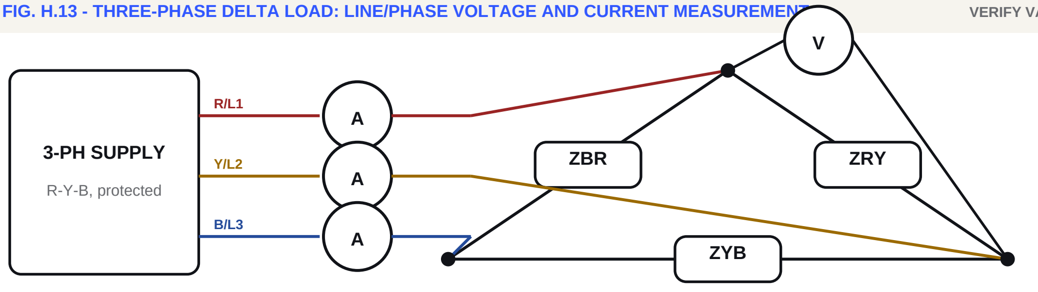
Key relations / checks

- Star: VL = sqrt(3) Vph and IL = Iph
- Delta: VL = Vph and IL = sqrt(3) Iph
- Balanced power P = sqrt(3) VL IL cos(phi)

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.13 - THREE-PHASE DELTA LOAD: LINE/PHASE VOLTAGE AND CURRENT MEASUREMENT VERIFY VALUES BEFORE USE



Measure VL, Vph and IL; for balanced delta IL = sqrt(3) Iph

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Isolated AC source / variac	Instructor-controlled	1
Load / trainer	R, L and C as required	1 set
True-RMS meters	Suitable CAT and ranges	1 set
Wattmeter / analyzer	Suitable rating	1
Leads and PPE	Inspected and approved	1 set

J. Safety and precautions

1. Do not energize or alter a circuit without instructor approval.
2. Use intact leads, correct instrument ranges, rated components and required PPE.
3. Switch OFF, isolate and verify absence of voltage before touching conductors.
4. Work on 230/415 V equipment only on an approved isolated trainer under direct supervision.

K. Procedure

1. Study the circuit or connection diagram, predict the expected result, and select instruments with suitable ranges.
2. Keep the supply OFF. Inspect leads and components, set controls to minimum, and make the circuit exactly as shown.
3. Ask the instructor to verify connections, polarity, earthing, instrument range and component ratings before energizing.
4. Switch ON using an isolated/current-limited source. Increase the input gradually and watch for abnormal heating or readings.
5. Take at least five sets of stable readings over the safe operating range and record units immediately.
6. Switch OFF before changing any connection. Repeat only the approved changes required by the experiment.
7. Calculate theoretical values and percentage error, plot the required characteristic where applicable, and state the result.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Line voltage	Line current	Power reading(s)	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Verify line and phase voltage/current relations for three-phase delta connection'? Answer: ______________________________
2	How are real, reactive and apparent power related in this circuit? Answer: ______________________________
3	What causes the phase difference between voltage and current? Answer: ______________________________
4	What safety step must be completed before changing a connection or configuration? Answer: ______________________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 14

Measure voltage, current, power and power factor in three-phase circuits

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure voltage, current, power and power factor in three-phase circuits.

B. Expected programme outcomes

PO1, PO2, PO4, PO5, PO6.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO4: Apply the principles of balanced three-phase systems.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

Key relations / checks

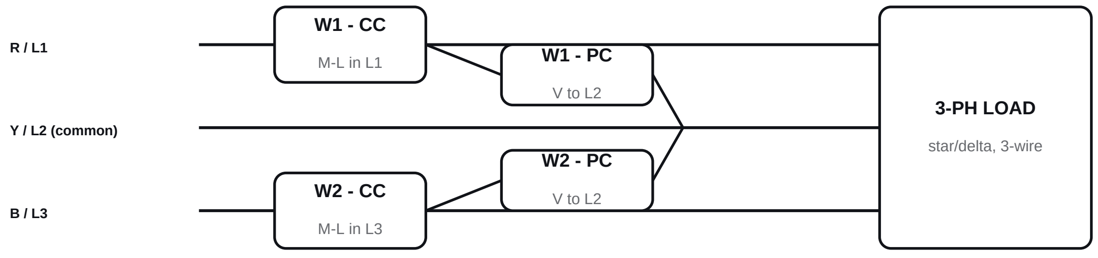
- Star: VL = sqrt(3) Vph and IL = Iph
- Delta: VL = Vph and IL = sqrt(3) Iph
- Balanced power P = sqrt(3) VL IL cos(phi)

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.14 - TWO-WATTMETER CONNECTION FOR THREE-PHASE THREE-WIRE POWER

VERIFY VALUES BEFORE USE



Total active power P = W1 + W2; use algebraic signs at low power factor

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Isolated AC source / variac	Instructor-controlled	1
Load / trainer	R, L and C as required	1 set
True-RMS meters	Suitable CAT and ranges	1 set
Wattmeter / analyzer	Suitable rating	1
Leads and PPE	Inspected and approved	1 set

J. Safety and precautions

1. Do not energize or alter a circuit without instructor approval.
2. Use intact leads, correct instrument ranges, rated components and required PPE.
3. Switch OFF, isolate and verify absence of voltage before touching conductors.
4. Work on 230/415 V equipment only on an approved isolated trainer under direct supervision.

K. Procedure

1. Study the circuit or connection diagram, predict the expected result, and select instruments with suitable ranges.
2. Keep the supply OFF. Inspect leads and components, set controls to minimum, and make the circuit exactly as shown.
3. Ask the instructor to verify connections, polarity, earthing, instrument range and component ratings before energizing.
4. Switch ON using an isolated/current-limited source. Increase the input gradually and watch for abnormal heating or readings.
5. Take at least five sets of stable readings over the safe operating range and record units immediately.
6. Switch OFF before changing any connection. Repeat only the approved changes required by the experiment.
7. Calculate theoretical values and percentage error, plot the required characteristic where applicable, and state the result.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Line voltage	Line current	Power reading(s)	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Measure voltage, current, power and power factor in three-phase circuits'? Answer: ____________________
2	How are real, reactive and apparent power related in this circuit? Answer: ____________________
3	What causes the phase difference between voltage and current? Answer: ____________________
4	What safety step must be completed before changing a connection or configuration? Answer: ____________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

PRACTICAL 15

Test the relation between power consumption in star and delta connected loads

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Test the relation between power consumption in star and delta connected loads.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Analyze and test single-phase and three-phase AC circuits using safe laboratory practice.

D. Expected course outcome

CO4: Apply the principles of balanced three-phase systems.

E. Practical learning outcomes

1. Prepare the circuit, select suitable ranges and predict the expected response.
2. Perform controlled measurements safely and record readings with correct units.
3. Compare measured and calculated results and explain the observed difference.

F. Affective-domain outcomes

1. Follow electrical safety, laboratory discipline and good housekeeping.
2. Record observations honestly with units, dates and traceable corrections.
3. Share instruments responsibly and complete the work within the allotted time.

G. Prerequisite theory

For sinusoidal steady state, RMS values and phase angle determine impedance, real power and power factor. Use V, I and P readings to calculate impedance Z = V/I and power factor cos(phi) = P/(V I) for single phase. For balanced three phase, P = sqrt(3) V_L I_L cos(phi).

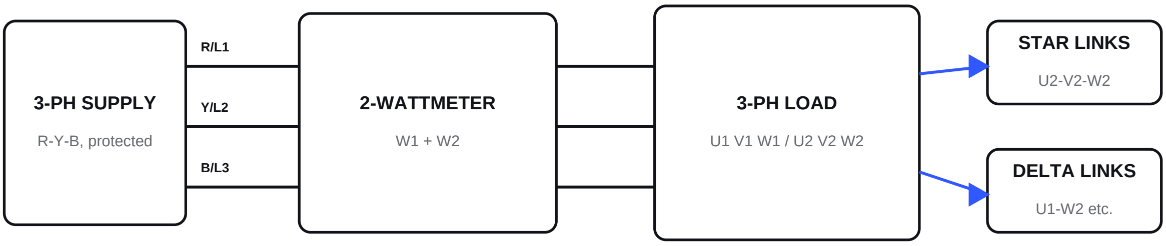
Key relations / checks

- Star: VL = sqrt(3) Vph and IL = Iph
- Delta: VL = Vph and IL = sqrt(3) Iph
- Balanced power P = sqrt(3) VL IL cos(phi)

H. Experimental setup / drawing

Study the experimental circuit below. Enter the component values, instrument ranges, terminal polarity and protection used in your laboratory, then obtain instructor approval before connection.

FIG. H.15 - SIX-TERMINAL THREE-PHASE LOAD FOR STAR/DELTA POWER COMPARISON VERIFY VALUES BEFORE USE



Keep line voltage and phase impedance unchanged; compare Pstar and Pdelta

Engineering-diagram note: Confirm the actual component values, ratings, terminal numbers, instrument ranges and protective measures issued by your laboratory. Faculty approval is mandatory before energizing.

I. Resources and equipment required

Resource	Specification / range	Quantity
Isolated AC source / variac	Instructor-controlled	1
Load / trainer	R, L and C as required	1 set
True-RMS meters	Suitable CAT and ranges	1 set
Wattmeter / analyzer	Suitable rating	1
Leads and PPE	Inspected and approved	1 set

J. Safety and precautions

1. Do not energize or alter a circuit without instructor approval.
2. Use intact leads, correct instrument ranges, rated components and required PPE.
3. Switch OFF, isolate and verify absence of voltage before touching conductors.
4. Work on 230/415 V equipment only on an approved isolated trainer under direct supervision.

K. Procedure

1. Study the circuit or connection diagram, predict the expected result, and select instruments with suitable ranges.
2. Keep the supply OFF. Inspect leads and components, set controls to minimum, and make the circuit exactly as shown.
3. Ask the instructor to verify connections, polarity, earthing, instrument range and component ratings before energizing.
4. Switch ON using an isolated/current-limited source. Increase the input gradually and watch for abnormal heating or readings.
5. Take at least five sets of stable readings over the safe operating range and record units immediately.
6. Switch OFF before changing any connection. Repeat only the approved changes required by the experiment.
7. Calculate theoretical values and percentage error, plot the required characteristic where applicable, and state the result.

L. Observations and calculations

Record instrument ranges and least counts. Enter observed readings first, then calculated values. Do not replace actual readings with expected values.

Trial	Applied value	Measured value 1	Measured value 2	Calculated result

SAMPLE CALCULATION WITH UNITS AND PERCENTAGE ERROR

GRAPH / PHASOR / CHARACTERISTIC / ADDITIONAL READINGS

M. Interpretation of results

COMPARE OBSERVED AND EXPECTED BEHAVIOUR; EXPLAIN ERROR, LIMITATIONS OR DESIGN TRADE-OFFS

N. Conclusion

STATE WHETHER THE PRACTICAL OUTCOME WAS ACHIEVED AND SUPPORT IT WITH KEY EVIDENCE

O. Practical-related questions

No.	Question / answer
1	What physical principle or engineering rule is verified in 'Test the relation between power consumption in star and delta connected loads'? Answer: ____________________
2	How are real, reactive and apparent power related in this circuit? Answer: ____________________
3	What causes the phase difference between voltage and current? Answer: ____________________
4	What safety step must be completed before changing a connection or configuration? Answer: ____________________

P. References and suggestions

1. B. L. Theraja, A Textbook of Electrical Technology, Volume I
2. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering
3. Current GTU syllabus DI02C00171 and institute laboratory instructions

Q. Assessment rubric (25 marks)

Assessment criterion	5 - Excellent	4 - Good	3 - Satisfactory	2/1/0 - Needs improvement	Marks
Correct circuit/interface/drawing interpretation	Complete, correct and independently prepared	Minor correction needed	Adequate with guidance	Major error, unsafe or incomplete	/5
Practical skill, measurement and safety	Systematic, accurate and safe	Sound method; small lapse	Acceptable with guidance	Weak method or unsafe practice	/5
Professional conduct and team contribution	Ethical, orderly and constructive	Responsible with minor lapse	Generally acceptable	Poor discipline or contribution	/5
Result interpretation and conclusion	Evidence-based and insightful	Correct with minor omission	Basic valid conclusion	Unsupported or incorrect	/5
Timely completion and record quality	Complete, neat and on time	Nearly complete and timely	Usable record	Late, unclear or incomplete	/5
TOTAL					/25

Faculty remarks	Student response / correction completed

Final submission checklist

1. Every practical has a date, mapped outcome, actual readings or evidence, calculations and a signed conclusion.
2. Circuit diagrams, programs, graphs, estimates, reports and test sheets are attached where required.
3. Instrument ranges, component ratings, source dates and safety precautions are recorded.
4. Technical sources are acknowledged and all assumptions are stated.
5. Faculty feedback and required corrections have been completed.

FACULTY REMARKS