VOLTBOOK / GTU DIPLOMA ELECTRICAL

Electrical Instrumentation

DETAILED OUTCOME-BASED PRACTICAL MANUAL

COURSE CODE	SEMESTER	PRACTICALS	EFFECTIVE FROM
DI03000091	3	16	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 Electrical Instrumentation (DI03000091) 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

Select, use and calibrate instruments and bridges for reliable electrical measurements.

Course outcomes

CO	Course outcome
CO1	Explain measurement and instrumentation terms and instrument characteristics.
CO2	Use potentiometers and DC/AC bridges for electrical measurement.
CO3	Use electromechanical instruments for measurement of electrical quantities.
CO4	Calibrate ammeters, voltmeters, wattmeters and energy meters.
CO5	Use transducers to measure non-electrical quantities.

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	Identify measuring instruments from dial symbols, type, accuracy class, position and scale	CO1
2	Measure medium resistance using a Wheatstone bridge	CO2
3	Measure low resistance using a Kelvin double bridge	CO2
4	Measure inductance using a Maxwell bridge	CO2
5	Measure inductance using a Universal Impedance bridge	CO2
6	Measure capacitance using a Universal Impedance bridge	CO2
7	Measure winding insulation resistance using a Megger	CO3
8	Measure earth resistance using an earth tester	CO3
9	Measure three-phase load power using the two-wattmeter method	CO3
10	Measure electrical parameters using a clamp meter	CO3
11	Test the phase sequence of a three-phase supply	CO3
12	Extend ammeter and voltmeter range using CT and PT	CO3
13	Extend ammeter and voltmeter range using shunt and multiplier	CO3
14	Calibrate an MI or MC ammeter as per applicable laboratory procedure	CO4
15	Calibrate an MI or MC voltmeter as per applicable laboratory procedure	CO4
16	Calibrate a wattmeter as per applicable laboratory procedure	CO4

Industry skills and laboratory guidance

Industry-relevant skills

- Range and accuracy selection
- Bridge balancing and null detection
- Calibration against a reference
- Error, correction and uncertainty reporting

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			
16			
TOTAL		/400	

Experiment index

Identify measuring instruments from dial symbols, type, accuracy class, position and scale 9

Measure medium resistance using a Wheatstone bridge 13

Measure low resistance using a Kelvin double bridge 17

Measure inductance using a Maxwell bridge 21

Measure inductance using a Universal Impedance bridge 25

Measure capacitance using a Universal Impedance bridge 29

Measure winding insulation resistance using a Megger 33

Measure earth resistance using an earth tester 37

Measure three-phase load power using the two-wattmeter method 41

Measure electrical parameters using a clamp meter 45

Test the phase sequence of a three-phase supply 49

Extend ammeter and voltmeter range using CT and PT 53

Extend ammeter and voltmeter range using shunt and multiplier 57

Calibrate an MI or MC ammeter as per applicable laboratory procedure 61

Calibrate an MI or MC voltmeter as per applicable laboratory procedure 65

Calibrate a wattmeter as per applicable laboratory procedure 69

PRACTICAL 01

Identify measuring instruments from dial symbols, type, accuracy class, position and scale

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Identify measuring instruments from dial symbols, type, accuracy class, position and scale.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO1: Explain measurement and instrumentation terms and instrument characteristics.

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

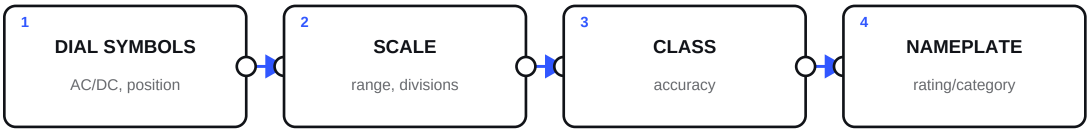
- State the governing relation before substitution
- Use consistent SI units
- % difference = |observed - expected|/expected x 100

H. Experimental setup / drawing

Study the labelled constructional, single-line or system diagram below and add the verified ratings, terminal designations and functional details for the item observed.

FIG. H.1 - INSTRUMENT DIAL AND NAMEPLATE IDENTIFICATION

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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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. Collect only instructor-approved de-energized samples, models, data sheets or trainer modules.
2. Read markings and nameplate information; record type, material, rating, construction and relevant standard symbol.
3. Inspect each item and identify terminals or functional parts without dismantling sealed or energized equipment.
4. Explain the operating principle and match each type to a suitable application.
5. Compare advantages, limitations, failure modes and safe handling requirements in the observation table.
6. Have the instructor verify the identification and record the final conclusion.

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 'Identify measuring instruments from dial symbols, type, accuracy class, position and scale'? Answer: ____
2	What are the range, least count and accuracy class of the instrument used? Answer: ____
3	What is loading effect, and can it influence this measurement? Answer: ____
4	What safety step must be completed before changing a connection or configuration? Answer: ____

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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

Measure medium resistance using a Wheatstone bridge

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure medium resistance using a Wheatstone bridge.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO2: Use potentiometers and DC/AC bridges for electrical measurement.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

Key relations / checks

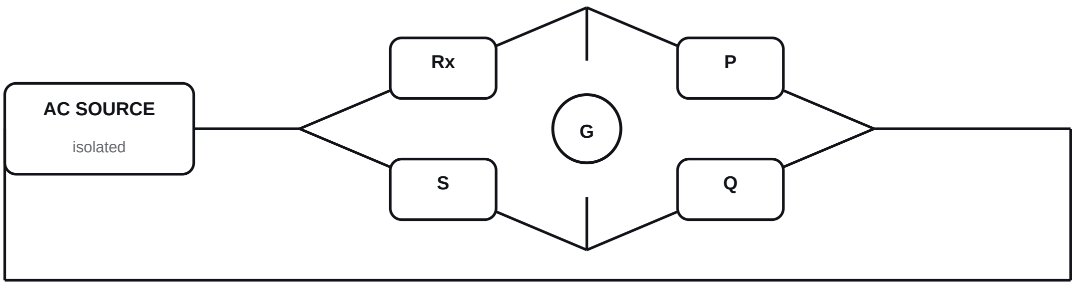
- V = I R
- P = V I = I^2 R = V^2/R
- % error = |measured - calculated| / calculated x 100

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.2 - WHEATSTONE BRIDGE FOR MEDIUM RESISTANCE

VERIFY VALUES BEFORE USE



Source across left-right nodes; detector/load across top-bottom nodes

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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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 medium resistance using a Wheatstone bridge'? Answer: ____
2	What are the range, least count and accuracy class of the instrument used? Answer: ____
3	What is loading effect, and can it influence this measurement? Answer: ____
4	What safety step must be completed before changing a connection or configuration? Answer: ____

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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 low resistance using a Kelvin double bridge

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure low resistance using a Kelvin double bridge.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO2: Use potentiometers and DC/AC bridges for electrical measurement.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

Key relations / checks

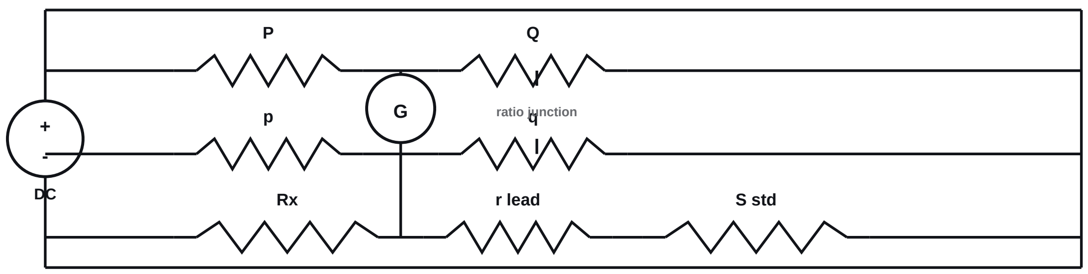
- V = I R
- P = V I = I^2 R = V^2/R
- % error = |measured - calculated| / calculated x 100

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.3 - KELVIN DOUBLE BRIDGE FOR LOW-RESISTANCE MEASUREMENT

VERIFY VALUES BEFORE USE



Use P/Q = p/q so the connecting-lead resistance r is eliminated at balance

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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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 low resistance using a Kelvin double bridge'? Answer: ______________________________
2	What are the range, least count and accuracy class of the instrument used? Answer: ______________________________
3	What is loading effect, and can it influence this measurement? Answer: ______________________________
4	What safety step must be completed before changing a connection or configuration? Answer: ______________________________

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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 using a Maxwell bridge

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure inductance using a Maxwell bridge.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO2: Use potentiometers and DC/AC bridges for electrical measurement.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

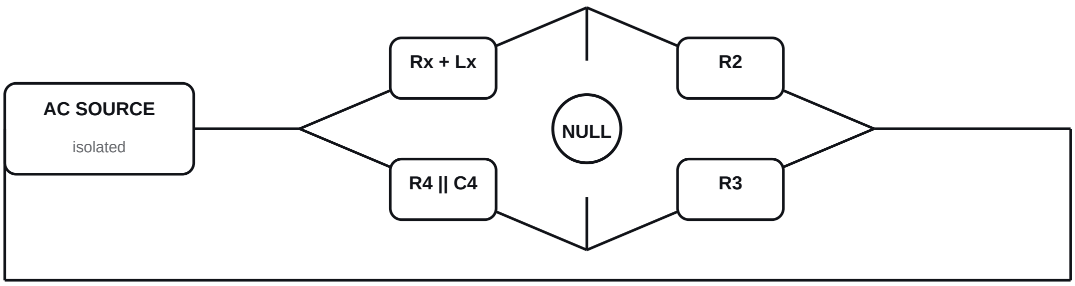
Key relations / checks

- e = -N d(phi)/dt
- v = L di/dt
- Inductive reactance XL = 2 pi f L

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 - MAXWELL BRIDGE FOR INDUCTANCE VERIFY VALUES BEFORE USE



Source across left-right nodes; detector/load across top-bottom nodes

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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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 using a Maxwell bridge'? Answer: ______________________________
2	What are the range, least count and accuracy class of the instrument used? Answer: ______________________________
3	What is loading effect, and can it influence this measurement? Answer: ______________________________
4	What safety step must be completed before changing a connection or configuration? Answer: ______________________________

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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 inductance using a Universal Impedance bridge

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure inductance using a Universal Impedance bridge.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO2: Use potentiometers and DC/AC bridges for electrical measurement.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

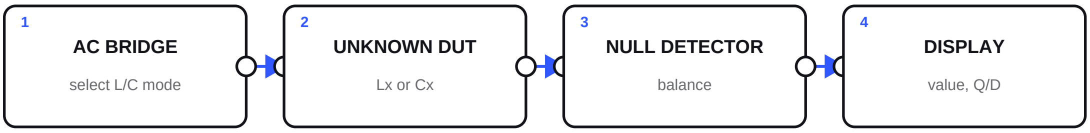
Key relations / checks

- e = -N d(phi)/dt
- v = L di/dt
- Inductive reactance XL = 2 pi f L

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 - UNIVERSAL IMPEDANCE BRIDGE CONNECTION 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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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 using a Universal Impedance bridge'? Answer: ______________________________
2	What are the range, least count and accuracy class of the instrument used? Answer: ______________________________
3	What is loading effect, and can it influence this measurement? Answer: ______________________________
4	What safety step must be completed before changing a connection or configuration? Answer: ______________________________

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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 capacitance using a Universal Impedance bridge

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure capacitance using a Universal Impedance bridge.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO2: Use potentiometers and DC/AC bridges for electrical measurement.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

Key relations / checks

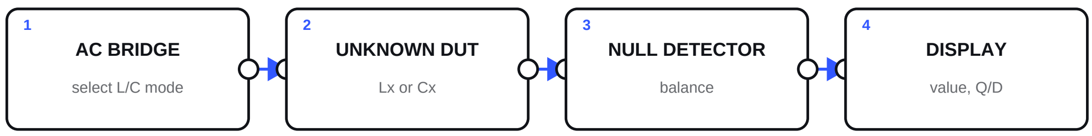
- Parallel: Ceq = C1 + C2 + ...
- Series: 1/Ceq = 1/C1 + 1/C2 + ...
- RC time constant: tau = R C

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 - UNIVERSAL IMPEDANCE BRIDGE CONNECTION

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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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 capacitance using a Universal Impedance bridge'? Answer: ____________________
2	What are the range, least count and accuracy class of the instrument used? Answer: ____________________
3	What is loading effect, and can it influence this measurement? Answer: ____________________
4	What safety step must be completed before changing a connection or configuration? Answer: ____________________

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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 winding insulation resistance using a Megger

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure winding insulation resistance using a Megger.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO3: Use electromechanical instruments for measurement of electrical quantities.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

Key relations / checks

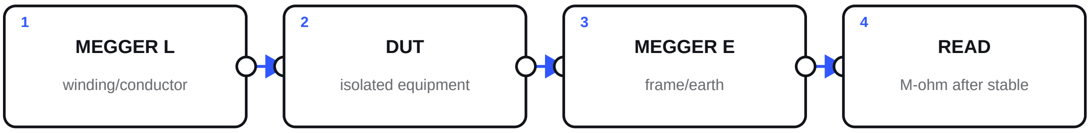
- State the governing relation before substitution
- Use consistent SI units
- % difference = |observed - expected|/expected x 100

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.7 - INSULATION-RESISTANCE MEASUREMENT

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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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 winding insulation resistance using a Megger'? Answer: ____________________
2	What are the range, least count and accuracy class of the instrument used? Answer: ____________________
3	What is loading effect, and can it influence this measurement? Answer: ____________________
4	What safety step must be completed before changing a connection or configuration? Answer: ____________________

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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 earth resistance using an earth tester

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure earth resistance using an earth tester.

B. Expected programme outcomes

PO1, PO2, PO4, PO5, PO6.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO3: Use electromechanical instruments for measurement of electrical quantities.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

Key relations / checks

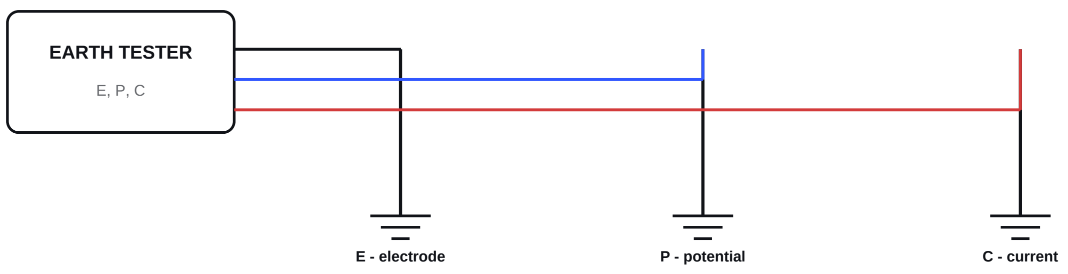
- State the governing relation before substitution
- Use consistent SI units
- % difference = |observed - expected|/expected x 100

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.8 - THREE-ELECTRODE EARTH-RESISTANCE TEST

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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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 earth resistance using an earth tester'? Answer: ____
2	What are the range, least count and accuracy class of the instrument used? Answer: ____
3	What is loading effect, and can it influence this measurement? Answer: ____
4	What safety step must be completed before changing a connection or configuration? Answer: ____

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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 three-phase load power using the two-wattmeter method

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure three-phase load power using the two-wattmeter method.

B. Expected programme outcomes

PO1, PO2, PO4, PO5, PO6.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO3: Use electromechanical instruments for measurement of electrical quantities.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

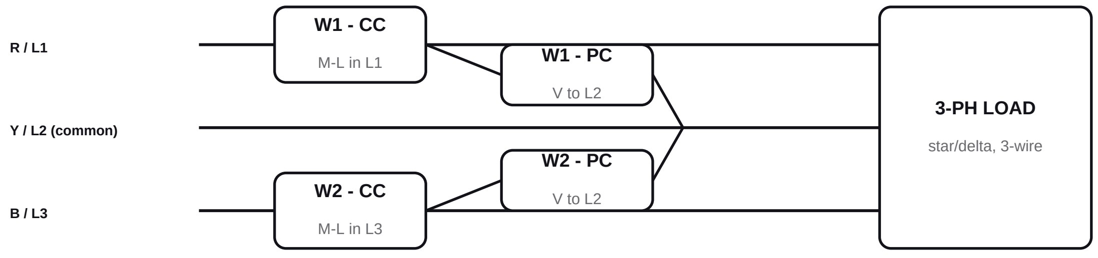
Key relations / checks

- 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.9 - 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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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 three-phase load power using the two-wattmeter method'? Answer: ____
2	What are the range, least count and accuracy class of the instrument used? Answer: ____
3	What is loading effect, and can it influence this measurement? Answer: ____
4	What safety step must be completed before changing a connection or configuration? Answer: ____

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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 electrical parameters using a clamp meter

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Measure electrical parameters using a clamp meter.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO3: Use electromechanical instruments for measurement of electrical quantities.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

Key relations / checks

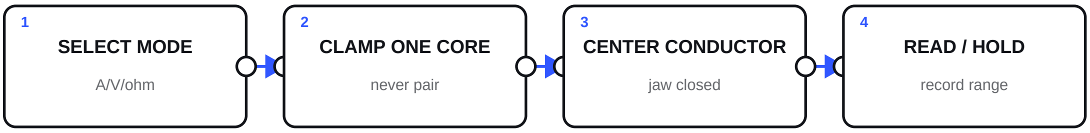
- State the governing relation before substitution
- Use consistent SI units
- % difference = |observed - expected|/expected x 100

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.10 - CLAMP-METER MEASUREMENT

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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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 electrical parameters using a clamp meter'? Answer: ______________________________
2	What are the range, least count and accuracy class of the instrument used? Answer: ______________________________
3	What is loading effect, and can it influence this measurement? Answer: ______________________________
4	What safety step must be completed before changing a connection or configuration? Answer: ______________________________

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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

Test the phase sequence of a three-phase supply

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Test the phase sequence of a three-phase supply.

B. Expected programme outcomes

PO1, PO2, PO4, PO5, PO6.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO3: Use electromechanical instruments for measurement of electrical quantities.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

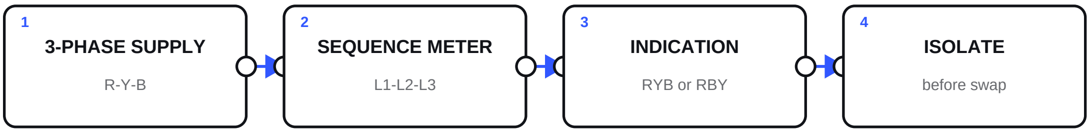
Key relations / checks

- 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.11 - PHASE-SEQUENCE TEST 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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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 'Test the phase sequence of a three-phase supply'? Answer: ______________________________
2	What are the range, least count and accuracy class of the instrument used? Answer: ______________________________
3	What is loading effect, and can it influence this measurement? Answer: ______________________________
4	What safety step must be completed before changing a connection or configuration? Answer: ______________________________

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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

Extend ammeter and voltmeter range using CT and PT

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Extend ammeter and voltmeter range using CT and PT.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO3: Use electromechanical instruments for measurement of electrical quantities.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

Key relations / checks

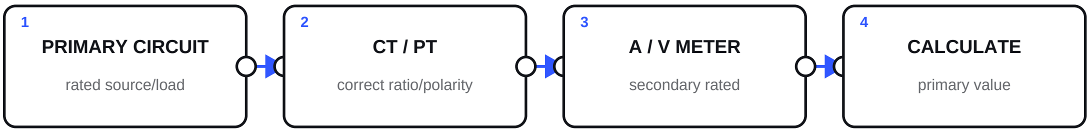
- State the governing relation before substitution
- Use consistent SI units
- % difference = |observed - expected|/expected x 100

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.12 - INSTRUMENT RANGE EXTENSION USING CT AND PT

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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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 'Extend ammeter and voltmeter range using CT and PT'? Answer: ____
2	What are the range, least count and accuracy class of the instrument used? Answer: ____
3	What is loading effect, and can it influence this measurement? Answer: ____
4	What safety step must be completed before changing a connection or configuration? Answer: ____

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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

Extend ammeter and voltmeter range using shunt and multiplier

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Extend ammeter and voltmeter range using shunt and multiplier.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO3: Use electromechanical instruments for measurement of electrical quantities.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

Key relations / checks

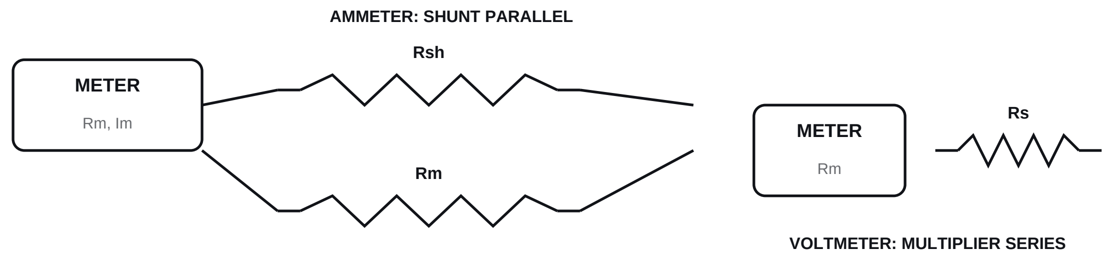
- State the governing relation before substitution
- Use consistent SI units
- % difference = |observed - expected|/expected x 100

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.13 - AMMETER SHUNT AND VOLTMETER MULTIPLIER

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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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 'Extend ammeter and voltmeter range using shunt and multiplier'? Answer: ____________________
2	What are the range, least count and accuracy class of the instrument used? Answer: ____________________
3	What is loading effect, and can it influence this measurement? Answer: ____________________
4	What safety step must be completed before changing a connection or configuration? Answer: ____________________

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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

Calibrate an MI or MC ammeter as per applicable laboratory procedure

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Calibrate an MI or MC ammeter as per applicable laboratory procedure.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO4: Calibrate ammeters, voltmeters, wattmeters and energy meters.

E. Practical learning outcomes

1. Connect the instrument and reference standard using suitable ranges.
2. Determine error and correction at several points over the working range.
3. Plot or tabulate the calibration characteristic and judge instrument performance.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

Key relations / checks

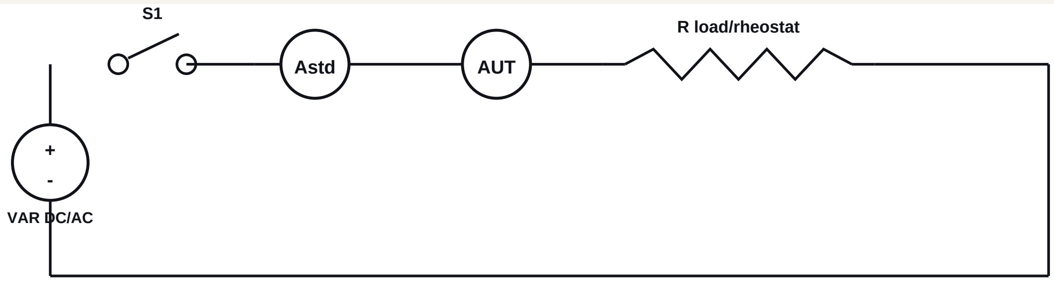
- Error = indicated value - standard value
- Correction = standard value - indicated value
- % error = error/full-scale value x 100

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.14 - AMMETER CALIBRATION BY COMPARISON

VERIFY VALUES BEFORE USE



Increase from zero in equal steps; record standard, indication, error and correction

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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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	Standard reading	Instrument reading	Correction	% error

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 'Calibrate an MI or MC ammeter as per applicable laboratory procedure'? Answer: ____
2	What are the range, least count and accuracy class of the instrument used? Answer: ____
3	What is loading effect, and can it influence this measurement? Answer: ____
4	What safety step must be completed before changing a connection or configuration? Answer: ____

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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

Calibrate an MI or MC voltmeter as per applicable laboratory procedure

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Calibrate an MI or MC voltmeter as per applicable laboratory procedure.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO4: Calibrate ammeters, voltmeters, wattmeters and energy meters.

E. Practical learning outcomes

1. Connect the instrument and reference standard using suitable ranges.
2. Determine error and correction at several points over the working range.
3. Plot or tabulate the calibration characteristic and judge instrument performance.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

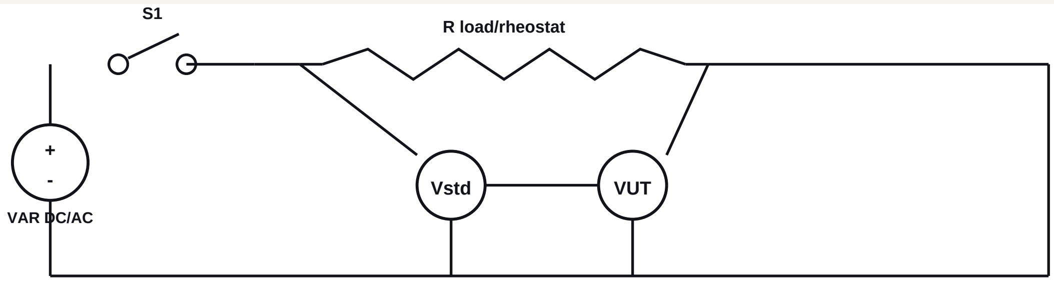
Key relations / checks

- Error = indicated value - standard value
- Correction = standard value - indicated value
- % error = error/full-scale value 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.15 - VOLTMETER CALIBRATION BY COMPARISON VERIFY VALUES BEFORE USE



Increase from zero in equal steps; record standard, indication, error and correction

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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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	Standard reading	Instrument reading	Correction	% error

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 'Calibrate an MI or MC voltmeter as per applicable laboratory procedure'? Answer: ____________________
2	What are the range, least count and accuracy class of the instrument used? Answer: ____________________
3	What is loading effect, and can it influence this measurement? Answer: ____________________
4	What safety step must be completed before changing a connection or configuration? Answer: ____________________

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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 16

Calibrate a wattmeter as per applicable laboratory procedure

DATE	BATCH	ROLL / ENROLLMENT NO.	FACULTY SIGN

A. Objective

Calibrate a wattmeter as per applicable laboratory procedure.

B. Expected programme outcomes

PO1, PO2, PO4, PO7.

C. Expected competency

Select, use and calibrate instruments and bridges for reliable electrical measurements.

D. Expected course outcome

CO4: Calibrate ammeters, voltmeters, wattmeters and energy meters.

E. Practical learning outcomes

1. Connect the instrument and reference standard using suitable ranges.
2. Determine error and correction at several points over the working range.
3. Plot or tabulate the calibration characteristic and judge instrument performance.

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

Measurement quality depends on instrument range, accuracy class, loading effect, zero error and traceability to a standard. Take readings within the rated range, compare against the reference value, calculate absolute and percentage error, and report uncertainty or limitations where relevant.

Key relations / checks

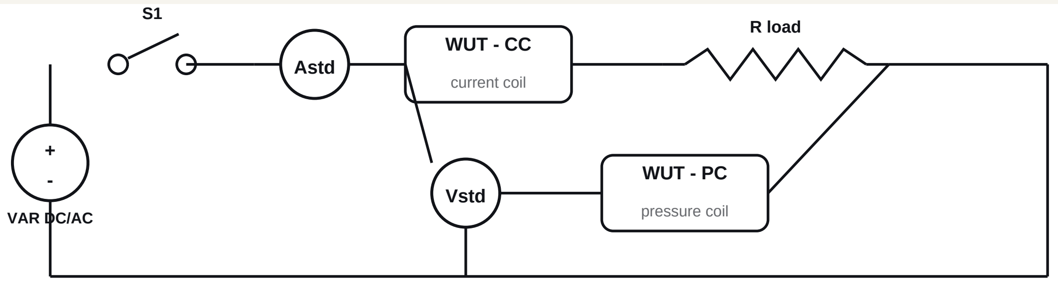
- Error = indicated value - standard value
- Correction = standard value - indicated value
- % error = error/full-scale value x 100

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.16 - WATTMETER CALIBRATION USING STANDARD V AND I

VERIFY VALUES BEFORE USE



Increase from zero in equal steps; record standard, indication, error and correction

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
Instrument / bridge	Named type and suitable range	1
Reference standard	Higher accuracy where applicable	1
Source	Regulated; AC/DC as required	1
Standards / components	Known values and ratings	As req.
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	Standard reading	Instrument reading	Correction	% error

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 'Calibrate a wattmeter as per applicable laboratory procedure'? Answer: ____________________
2	What are the range, least count and accuracy class of the instrument used? Answer: ____________________
3	What is loading effect, and can it influence this measurement? Answer: ____________________
4	What safety step must be completed before changing a connection or configuration? Answer: ____________________

P. References and suggestions

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation
2. H. S. Kalsi, Electronic Instrumentation
3. Current GTU syllabus DI03000091 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