GOVERNMENT OF WESTERN AUSTRALIA

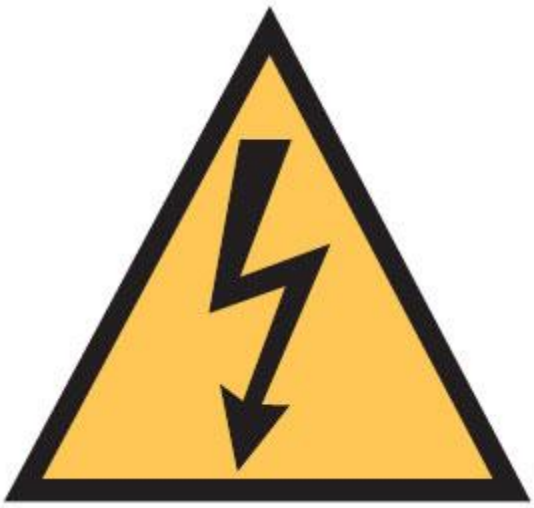
TAFE WA North Metropolitan

RTO Code: 52786

Portfolio of evidence Part B

UEEEL0020

Solve problems in low voltage a.c. circuits



UEE Training Package Support Material

Based on:
National Electrotechnology Industry Standards

North Metropolitan TAFE
V1 July 2022

Assessment Task 3 Portfolio of Evidence

Qualification national code and title	UEE30820 Certificate III in Electrotechnology Electrician
Unit/s national code/s and title/s	UEEEL0020 - Solve problems in low voltage a.c. circuits

Student Name		**Assessment Type**	☐	Questioning (Oral / Written)
Student ID			☒	Portfolio
Lecturer Name		**Student Result (S/NYS)**		

By completing and submitting this signed form to my lecturer, I am stating that:

a. The attached submission is completely my own work
b. I have correctly cited all sources of information used in this work (if required)
c. I understand a copy of my assessment will be kept by the NMTAFE for their records
d. I understand my assessment may be selected for use in the NMTAFE's validation and audit process to ensure student assessment meets requirements

Student Signature		**Date**	

Assessment type (☑):

☐ Questioning (Oral/Written)

☐ Practical Demonstration

☐ 3rd Party Report

☒ Other – Project/Portfolio *(please specify)*

Assessment Resources:

Resources the assessor is to provide:

- Classroom setting as the venue.
- Test paper
- Graph paper

Resources the candidate is to provide:

- Black or Blue pen
- Pencil and eraser
- Scientific calculator (non-programmable)
- Maths drawing set
- AS/NZS 3000: current edition
- AS/NZS 3008.1.1 current edition
- WA Electrical Requirements current edition

Assessment Instructions:

Assessment Task 3 Portfolio of Evidence

Qualification national code and title	UEE30820 Certificate III in Electrotechnology Electrician
Unit/s national code/s and title/s	UEEEL0020 - Solve problems in low voltage a.c. circuits

Task description:

The following Portfolio Assessment relates to the knowledge requirements and performance evidence of the unit. Make sure you complete all questions and practical activities

- To be deemed ***Satisfactory*** you are required to achieve a mark of **100%**
- The following **Knowledge Assessment** is an open book assessment and does not need to be completed under supervision
- The following **Practical Activities** must be completed under supervision in a simulated workplace environment
- If ***Not Yet Satisfactory*** you will be required to re-attempt the **Knowledge Questions** that are marked ***not satisfactory*** and/or any **Practical Activity** marked as **Not Yet Satisfactory**

Student Instructions:

Ensure you have access to all the resources required for this assessment as described below.

1. Read the **Questions** section. If you are not clear about a question, ask your assessor for further information.
2. You may be able to complete the questions verbally. This would need to be negotiated with your assessor**.**
3. Your assessor will provide feedback on your answers, including any questions that may require a further response.
4. If you have specific needs that you would like considered during this assessment, please discuss this with your assessor to identify any possible reasonable adjustments **prior** to commencing the assessment.
5. All diagrams must be neat, labelled and in pencil.
6. All calculations and numerical answers must be shown correct to two decimal places and include both the unit of measurement and metric prefix if applicable.

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LABORATORY INSTRUCTIONS

Students working in laboratories at North Metropolitan TAFE Campus's do so on the condition that they agree to abide by the following instructions. Failure to observe the safety instructions may result in disciplinary action up to and including cancellation of your training contract with NMTafe.

1. No circuit is to be plugged in or switched on without the specific permission of the lecturer in charge of the class. A circuit must be switched off, isolated and tested for ZERO VOLTS before any supply leads are removed. The DANGER TAG PROCEDURE must be used at all times.
2. Do not leave any circuit switched on any longer than necessary for testing. Do not leave any circuit switched on unattended.
3. Check each item of equipment before using. Report any broken, damaged or unserviceable equipment to your Lecturer.
4. All wiring must be disconnected at the end of each practical class or as each project is completed.
5. Make all connections in a safe manner with an appropriate connecting device. Unshielded 4mm banana plugs are not to be used for wiring.
6. Switch off, remove the plug from the socket and attach your DANGER TAG to the plug top before working on any project. It is not sufficient to simply turn the switch off.
7. When disconnecting your wiring from a connection made under a screw, undo the screw to remove the wiring, do not cut the wire off.
8. Observe the correct colour code for all wiring projects.
9. Test your circuit for short circuits with your multimeter before asking your Lecturer to switch circuit on. Test the Tester before and after EACH test.
10. Where an activity sheet is issued for a project, complete each step in the Procedure before moving to the next step. Advise your Lecturer when you have completed the activity.
11. Draw ALL DIAGRAMS in PENCIL so that they can be easily changed or corrected. Mark off each connection on your diagram as it is made.
12. Check the range before taking a reading with a multimeter.
13. Make sure that it is YOUR plug before inserting plug into an outlet.
14. Always switch multimeter OFF, or to the highest possible AC VOLTS range when you have finished using it.
15. Report any unexpected situations or events to your Lecturer.

Student's Signature _____ Date: _____

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DANGER TAG PROCEDURE for ELECTRICAL TRADE LABORATORIES

THE FOLLOWING PROCEDURE IS COMPULSORY

1. The student is to attach a DANGER TAG on to the plug top of the project lead before proceeding with the allocated project. A danger tag must be attached to the plug top at all times, when the lead is NOT plugged into the supply outlet. Plug tops or leads are not to be connected to the supply outlet WHILE A DANGER TAG is attached.

2. The student is to assemble the project according to project instruction procedure and lecturer's directions in its isolated and de-energised state and report to the lecturer as necessary and on completion.

3. The lecturer is to:-
   a. Check the project for safety and
   b. Ensure that the student has performed a safety check, including a short circuit test using the recommended procedure.

4. When the lecturer is satisfied that the project is safe to connect and energise the lecturer is to instruct the student to REMOVE the DANGER TAG from the plug top.

5. The student is to plug in the project and switch it on in the presence of the lecturer.

6. The lecturer is to determine whether or not the project is operating satisfactorily.

7. If the project operates satisfactorily the student may take measurements using correct meters with regard to the safety risks associated with using the particular item of test equipment including;
   a. Selecting correct meter function,
   b. Holding meter probes correctly during measuring with fingers behind knurls (finger guards) at all times.

   This is to be done under general supervision of lecturer. The student is NOT to modify, disassemble or carry out ANY unsafe act.

8. If the circuit is to be modified the student must:

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a. Switch the circuit off,
b. Disconnect the project from the supply,
c. Attach the DANGER TAG to the plug top,
d. Report to the lecturer for instructions,
e. In the lecturer's presence the student is to:-
f. TEST and VERIFY for ZERO VOLTAGE.
g. Restart the DANGER TAG procedure from step 2 above.

9. When the student is satisfied that the project has been completed the student is to:-
   a. Switch the project off,
   b. Remove the plug,
   c. Replace the DANGER TAG on the plug top,
   d. Report to the lecturer for instructions,

   In the lecturer's presence the student is to:-
   e. TEST and VERIFY for ZERO VOLTAGE.

   The lecturer is then to instruct the student to:-
   f. Disassemble the project
   g. Remove the DANGER TAG and store the equipment in its designated place.

Failure to follow Danger Tag Procedures when working on practical activities and practical assessments will result in a '**Not yet Satisfactory'** comment recorded for this Unit of Competency

Student's Signature _____ Date: _____

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Complete all Knowledge Questions.

Question 1	An inductive load connected to a 230 V 50 Hz AC circuit takes 15 A from the supply. The phase angle between the load current and supply voltage is 27º lagging. Calculate: **a** the true power **b** the reactive power **c** the apparent power taken by the load **d** the circuit power factor		
Answer	**A**		
	B		
	C		
	D		
Feedback			☐ Satisfactory ☐ Not satisfactory

Question 2	A 230 V 50 Hz contactor coil has an inductance of 0.2 H and an effective resistance of 15 ohms. Find the power factor of the circuit supplying the coil.	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 3	An AC power source is delivering 32 kW of true power and 12 kVA_R of reactive power to a load. **a** How much apparent power is the source providing **b** What is the power factor?		
Answer	**A**		
	B		
Feedback			☐ Satisfactory ☐ Not satisfactory

Question 4	A single phase AC motor on full load takes a current of 26 A from a 400 V 50 Hz supply at a lagging power factor of 0.85. Calculate the: **a** true power taken by the motor **b** phase angle between supply current and voltage **c** apparent power provided by the supply source **d** reactive power taken by the motor		
Answer	**A**		
	B		
	C		
	D		
Feedback			☐ Satisfactory ☐ Not satisfactory

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Question 5	A wattmeter measures a value of 12.5 kW taken by a load connected to a 400 V supply. An ammeter measuring the current to the load registers 36.25 A. **a** Determine the power factor of the circuit **b** Calculate the phase angle between the current and supply voltage		
Answer	**A**		
	B		
Feedback			☐ Satisfactory ☐ Not satisfactory

Question 6	An electrical circuit is taking 15 kW of true power and 6 kVA_R of reactive power. **a** How much apparent power is the supply source providing? **b** What is the power factor?		
Answer	**A**		
	B		
Feedback			☐ Satisfactory ☐ Not satisfactory

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Question 7	An ideal 0.8 H inductor is connected to a 400 V 50 Hz supply. **a** How much true power does it consume? **b** How much apparent power does the supply source need to provide? **c** What is the circuit's power factor?		
Answer	**A**		
	B		
	C		
Feedback			☐ Satisfactory ☐ Not satisfactory

Question 8	A load connected to a 600 V 50 Hz supply takes a current of 25 A at a lagging power factor of 0.6. **a** Determine the value and reactive power rating of a capacitor needed to improve the power factor to 0.95 (lagging) **b** The current taken by the load after the capacitor is connected.		
Answer	**A**		
	B		
Feedback			☐ Satisfactory ☐ Not satisfactory

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Question 9	A three-phase alternator produces a maximum voltage of 550 V. Determine the voltage of each phase when phase A is at a rotational angle of 30°.	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 10	A star-connected power source has a phase voltage of 110 V and a line current of 25 A. **a** What is the line voltage? **b** What is the phase current?		
Answer	**A**		
	B		
Feedback			☐ Satisfactory ☐ Not satisfactory

Question 11	A delta-connected supply has a phase voltage of 16 kV and a line current of 15 A. **a** What is the line voltage? **b** What is the phase current?		
Answer	**A**		
	B		
Feedback			☐ Satisfactory ☐ Not satisfactory

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Question 12	A commercial espresso coffee machine has three heating elements, each with a resistance of 46 Ω and connected in star to a 400 V three-phase supply. Determine the: **a** current in each element **b** What is the phase current?		
Answer	**A**		
	B		
Feedback			☐ Satisfactory ☐ Not satisfactory

Question 13	A motor connected to a three-phase 400 V supply takes a line current of 25 A at a lagging power factor of 0.85. How much power is being consumed by the motor?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 14	An unbalanced star-connected resistive load has 30 A in A phase, 20 A in B phase and 40 A in C phase. Determine the neutral current.	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 15	An 3.3 kV delta-connected three-phase supply has 22 A flowing in each of its phase windings when it is supplying a delta-connected load. Calculate: **a** the line current **b** the impedance of each phase of the load.		
Answer	**A**		
	B		
Feedback			☐ Satisfactory ☐ Not satisfactory

Question 16	A three-phase motor consumes 20 kW at a power factor of 0.75 when connected to a 400 V three-phase supply. Calculate: **a** the line current **b** apparent power taken from the supply **c** the reactive power taken by the motor.		
Answer	**A**		
	B		
	C		
Feedback			☐ Satisfactory ☐ Not satisfactory

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Question 17	A three-phase star-connected unbalanced load is supplied by a 400 V three-phase supply. The current in phase A is 10 A (p.f. = 0.75 lag); in phase B current is 6.5 A (p.f. = 0.9 lag), and phase C has a current of 12 A (p.f. = 1). Determine the total power consumed by the load.	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 18	Harmonics can be defined as which of the following: • The frequency at which a wave oscillates • Multiples of the fundamental frequency • The resonant frequency • The number of cycles per second	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 19	State one effect of harmonics?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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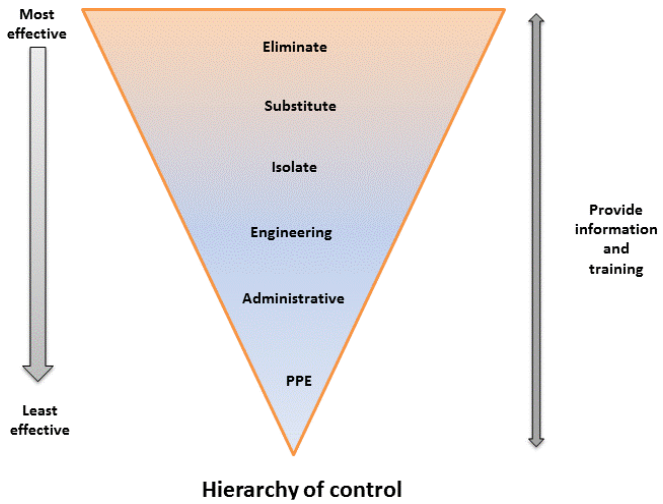
Practical Activities Overview

Risk assessment

Consequence		1 **Rare** The event may occur in exceptional circumstances	2 **Unlikely** The event could occur sometimes	3 **Moderate** The event should occur sometimes	4 **Likely** The event will probably occur in most circumstances	5 **Almost Certain** The event is expected to occur in most circumstances
1	**Insignificant** No injuries or health issues	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE**
2	**Minor** First aid treatment	**LOW**	**LOW**	**MODERATE**	**MODERATE**	**HIGH**
3	**Moderate** Medical treatment, potential LTI	**LOW**	**MODERATE**	**HIGH**	**HIGH**	**CRITICAL**
4	**Major** Permanent disability or disease	**LOW**	**MODERATE**	**HIGH**	**CRITICAL**	**CATASTROPHIC**
5	**Extreme** Death	**MODERATE**	**HIGH**	**CRITICAL**	**CATASTROPHIC**	**CATASTROPHIC**

1. **Eliminate** – if it is possible, the hazard should be removed completely. For example, get rid of dangerous machines.
2. **Substitute** – replace something that produces the hazard with something that does not produce a hazard. For example, replacing solvent based paint with water based paint. Risk assessment on the substitution must be conducted to ensure that it will not pose another hazard.
3. **Engineering control** – isolate a person from the hazard by creating physical barrier or making changes to process, equipment or plant to reduce the hazard. For example, install ventilation systems.
4. **Administrative control** – change the way a person works by establishing policies and procedures to minimise the risks. For example, job scheduling to limit exposure and posting hazard signs.
5. Use **personal protective equipment** (PPE) – protect a person from the hazard by wearing PPE. For example, wearing gloves, safety glasses, hard hats and high-visibility clothing. PPE must be correctly fitted, used and maintained to provide protection.



Hierarchy of control

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Safe Work Method Statement

Revised Risk Rating							
Hazard Control Measures							
Risk Rating							
Hazards							
Task Steps							
Task Step #							

Student Signature.....

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Practical Activity 1

Power Factor in a Single 36 W Fluorescent Circuit

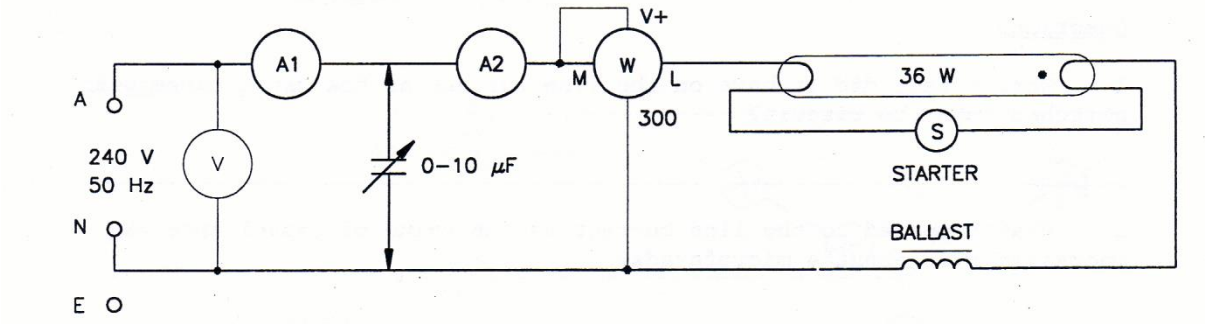
Objective

To observe the effects of changing the capacitance in a standard single 36 watt fluorescent circuit.

Equipment

240 volt 50Hz a.c. supply
One single 36 (or 40) watt fluorescent unit
A variable 240 V switchable paper capacitor bank (about 2 to 10 µF).
A 0-100 W single phase analogue wattmeter or similar
Two 0 – 1 amp a.c. ammeters
Multimeter
Single phase power board
Connecting leads

Circuit Diagram



Procedure

DANGER TAG PROCEDURE REQUIRED

1. Connect the circuit according to the circuit diagram given above. Make sure that the settings on the variable capacitor bank are such that there is no capacitance connected in the circuit.
2. Check for short circuits with a multimeter set on the ohms times 1 range. Switch the multimeter off after the check.
3. Have your connections checked by your Lecturer

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4. Switch the circuit on and record the meter readings in the Results Table.
5. Switch the capacitance into the circuit in increments of about 2 microfarads and record the meter readings for each setting.
6. Switch the circuit off, remove the plug from the outlet and attach your danger tag to the plug top
7. Have your results checked by your Lecturer
8. Disconnect your wiring and return all of the equipment to its proper place

Results Table

	µF	Line E	Line I	I_2	Power	Cos Θ
No Capacitance	0 µF					
Setting 1						
Setting 2						
Setting 3						
Setting 4						
Setting 5						

Questions

1. What effect did it have on the line current as the capacitance was switched into the circuit?

_____

2. What happened to the line current as the value of capacitance was increased over about 4 microfarads?

_____

3. What happened to the reading on the wattmeter as the capacitance was switched into the circuit?

_____

4. What happened to the reading on ammeter I_2 as the capacitance was switched into the circuit?

_____

Answer		☐ Satisfactory ☐ Not satisfactory

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Practical Activity 2

Three Phase Star and Delta Circuits

Objective

To verify the voltage and current ratios (relationships) in three phase balanced star and delta circuits.

Equipment

Three phase star/delta project board (resistive loads only)
Three phase supply
Tong tester
Multimeter

Circuit Diagrams

Star **Delta**

Procedure

DANGER TAG PROCEDURE REQUIRED

1. Draw a circuit diagram showing how the project board should be connected as a balanced three phase STAR connection. Show how suitable meters would have to be connected to measure line current, phase (or coil) current, line voltage and phase (or coil) voltage for one phase.

2. Connect the circuit according to your diagram. Position the instruments so that the ammeters are together and the voltmeters are together, Have your diagram and connections checked by your Lecturer.

3. Plug the circuit into a three phase outlet and record all instrument readings in the Results Table.
4. Switch the circuit off and remove the plug from the outlet. Attach your danger tag to the plug-top.
5. Check for zero volts, then repeat Steps 1-5 for a DELTA connection.
6. Have your results checked by your Lecturer

Results Table

Results Table

	STAR	DELTA
Line E		
Phase E		
Line I		
Phase I		

Questions

1. Complete the equations to express the ratio between each of the following quantities in a balanced three phase circuit:

Star		Delta	
Line E =	_____	Line E =	_____
Phase E =	_____	Phase E =	_____
Line I =	_____	Line I =	_____
Phase I =	_____	Phase I =	_____

2 If the line current in a balanced three phase star connected circuit was 10 amps, what would the phase current be?

---

3 If the line current in a balanced three phase delta connected circuit was 10 amps, what would the phase current be?

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4 If the line voltage in a balanced three phase star connected circuit was 300 volts, what would the phase voltage be?

5 If the line voltage in a balanced three phase delta connected circuit was 300 volts, what would the phase voltage be?

Answer		☐ Satisfactory ☐ Not satisfactory

Practical Activity 3

Out-of-balance Current in the Neutral

Objective

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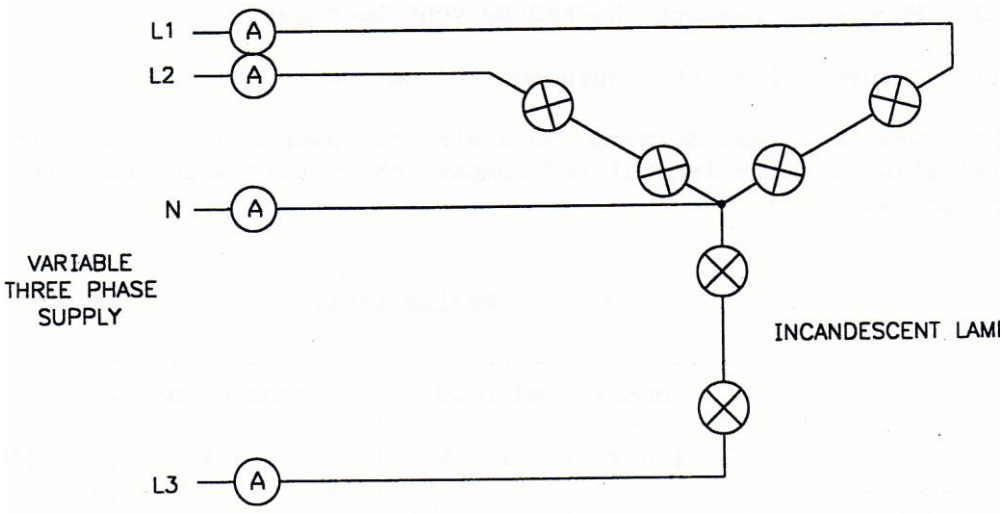
To measure the out-of balance current in the neutral of a three phase unbalanced and balanced star connected system and verify the results by graphical construction.

Equipment

Three phase star connected unbalanced load project board
Two 15 W 240 volt incandescent lamps
Two 40 W 240 volt incandescent lamps
Two 60 W 240 volt incandescent lamps
0-415 volt a.c. voltmeter
Four 0-1 amp volt a.c. ammeters
Calculator or mathematical tables

Circuit Diagram



Procedure

DANGER TAG PROCEDURE REQUIRED

1 Connect the lamps in STAR, and to a 0-415 volt variable three phase supply (Variac).Set the Variac to the zero volts position.

2 Insert 240 volt lamps in the circuit so that each phase has two IDENTICAL lamps in series, with different wattage lamps in each phase (an unbalanced load).

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3 Check for short circuits with a multimeter set on the ohms times 1 range. Switch the multimeter off after the check.

4 Switch the circuit on and increase the setting on the Variac until the output line voltage is 200 volts. Measure the current in Line 1, Line 2, Line 3 and the neutral and record the results in the Results Table.

5 Reduce the setting on the Variac until the output line voltage is 100 volts. Measure the current in Line 1, Line 2 and Line 3 and the neutral and record the results in the Results Table.

6 Switch the circuit off, remove the plug from the outlet and attach your danger tag to the plug top.

7 Re-arrange the circuit so that all six lamps in the circuit are the same power rating (a balanced load)

8 Check for short circuits with a multimeter set on the ohms times 1 range. Switch the multimeter off after the check

9 Switch the circuit on and increase the setting on the Variac until the output line voltage is 200 volts. Measure the current in Line 1, Line 2, Line 3 and the neutral and record the results in the Results Table

10 Remove both lamps from one phase and record all ammeter readings in the Results Table

11 Switch the circuit off, remove the plug from the outlet and attach your danger tag to the plug top

12 Have your results checked by your lecturer

13 Return all of the equipment to its proper place

14 Draw a phasor diagram (to scale) for each 415 volt condition (unbalanced and balanced) and compare the result with the readings obtained on the ammeters

Results Table

	Unbalanced Load	**Balanced Load**	**Two Phases**
	415 V	**415 V**	**415 V**
Line 1	**A**	**A**	**A**
Line 2	**A**	**A**	**A**

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Line 3	**A**	**A**	**A**
Neutral	**A**	**A**	**A**

Phasor Diagrams

Questions

1 Were the results obtained by graphical construction identical to those obtained by measurement? If not, how can you account for the difference(s)?

2 Why would it be dangerous to connect two different 240 volt incandescent lamps in series across 415 volt supply?

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3 What is the minimum permissible current carrying capacity of the neutral conductor in a three phase supply in which the consumer's mains have a current rating of 100 amps. Give the AS/NZS 3000:2018 Wiring Rules Clause number.

4 A three phase load consisting mainly of individual consuming devices connected between active and neutral has a current of 50 amps in each phase. How much current would flow in the neutral if the circuit was operating normally? How much current would flow in the neutral if the fuse in one phase 'blew'?

5 What two conditions must be met for the current in the neutral of a three phase star connected supply to be zero?

6 Determine the out-of-balance current in the neutral of the following CBA three phase circuit by the Triangle method construction:

Red Phase:	80 amps	0.8 lagging
White Phase:	60 amps	0.8 lagging
Blue Phase:	35 amps	0.8 lagging

Answer		☐ Satisfactory ☐ Not satisfactory

Practical Activity 4

THREE PHASE POWER MEASUREMENT

Objective

To measure the total true power in a three phase balanced resistive load using the 'two wattmeter' method

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Equipment

Three phase unbalanced load project board (resistive loads only)
Two wattmeters to suit the load
Three phase 415 volt power board

Circuit Diagram

Procedure

DANGER TAG PROCEDURE REQUIRED

1 Draw a circuit diagram showing how the true power can be measured in a three phase three wire unbalanced load using the two wattmeter method.

2 Connect the circuit according to your diagram. Have your diagram and connections checked by your Lecturer.

3 Switch the circuit on and record the wattmeter readings in the Results Table 1.

4 Switch the circuit off and remove the plug from the outlet. Attach the danger tag to the plug-top.

5 Have your results checked by your Lecturer

6 Disconnect your wiring and return all of the equipment to its proper place.

Table 1 (Two Wattmeter Method)

Wattmeter 1	

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Wattmeter 2	
Total Power:	

Questions

1 What condition is indicated if the wattmeters are connected correctly, but one instrument tends to read down-scale instead of up-scale? What corrective action should you take to obtain a correct power reading?

2 What condition is indicated if the wattmeters are connected correctly, and one instrument indicates zero watts?

3 What condition is indicated if the wattmeters are connected correctly, and both instruments have exactly the same reading?

Answer		☐ Satisfactory ☐ Not satisfactory

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Reasonable Adjustment			
Adjustment Required	☐ **Yes**	☐ **No**	
Describe the adjustments that have been made to the assessment:			
Assessor name and signature		**Date**	
Student name and signature		**Date**	

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Assessment Outcome Knowledge Questions	☐ **Satisfactory**	☐ **Not Satisfactory**
Assessment Outcome Practical Activities	☐ **Satisfactory**	☐ **Not Satisfactory**

Knowledge Questions / Practical Activity Feedback:

Actions Required if Not Satisfactory:

Assessor name and signature		**Date**	
Student name and signature		**Date**	