Topic Skills Practice Cover Sheet

Unit Name:	UEEEL0020 Solve problems in low voltage a.c. circuits
Topic Title:	Alternating Current Quantities

Skill Practice Number:	1.4
Skill Practice Name:	Measure a.c. Voltage and Frequency

Student Name:	
Student ID:	
College/Campus:	
Group:	

Results	
Planning:	
Carryout:	
Completion:	
Overall Results:	
Comments:	

Topic Skills Practice 1.4

UEEEL0020 Solve problems in low voltage a.c. circuits

Topic 1. Alternating Current Quantities

Skills Practice 1.4: Measure a.c. Voltage and Frequency

Task:

To practice setting up a CRO and to measure the a.c. voltage and frequency of a sine wave and a square wave.

Objectives:

At the completion of this skills practice, you should be able to:

- Set up a function generator and CRO to take measurements.
- Use a CRO to measure the frequency and voltage of a sine wave and a square wave.

Topic Skills Practice 1.4

1. Planning the Skills Practice

1.1 Equipment

- Function generator or audio signal generator
- Dual trace CRO
- CRO Probes

1.2 Suggested Materials

- N/A

1.3 Miscellaneous Items

- Connection leads
- PPE
- Pens/pencils

1.4 Risk Assessment

1.4.1 Risk assessment procedure:

- Identify any hazards that may exist with this skills practice below
- List the supervision level you will be working under - Direct (D), General (G) or Broad (B)
- List the risk classification – High Risk (H), Medium Risk (M) or Low Risk (L)
- List the control measures required for each identified hazard that you need to implement.

Hazard/s Identified	Supervision Level (D, G or B)	Risk Classification (H, M or L)	Control Measure/s

	Feedback	Have your teacher/trainer check your risk assessment	Teacher/Trainer Initials and Date	✓

Topic Skills Practice 1.4

2. Carrying Out the Skills Practice

2.1 Set Up the Function Generator and CRO

2.2.1 Connect the output terminals of a function generator to channel A or 1 of the CRO. The earth of the generator must go to the earth of the CRO. Also, if fitted, make sure the CRO probe switch is set to its x1 position.

2.2.2 Set the trigger control of the CRO to automatic and the input mode to a.c.

2.2.3 Set the controls of the function generator so the output level is about midway and the frequency is about 5 kHz.

2.2.4 Switch on the CRO and the function generator then adjust the CRO to obtain at least one whole cycle across the screen. You'll need to adjust the following controls:

- Both the X and Y shift controls to position the waveform centrally.
- The trigger control to 'lock' the waveform.
- The volts/div switch to obtain a trace that fits vertically in the screen.
- The sweep time/div switch to obtain around one whole cycle on the screen.
- Make sure the controls for the volts/div and sweep time/div switches are OFF.

2.2.5 Enter the final settings of Sweep Time/Division and Volts/Division in Table 1

- Once the waveform is correctly displayed, its peak-to-peak voltage and its period and frequency can be determined. Figure 1 shows a sine wave and the measurement points required.

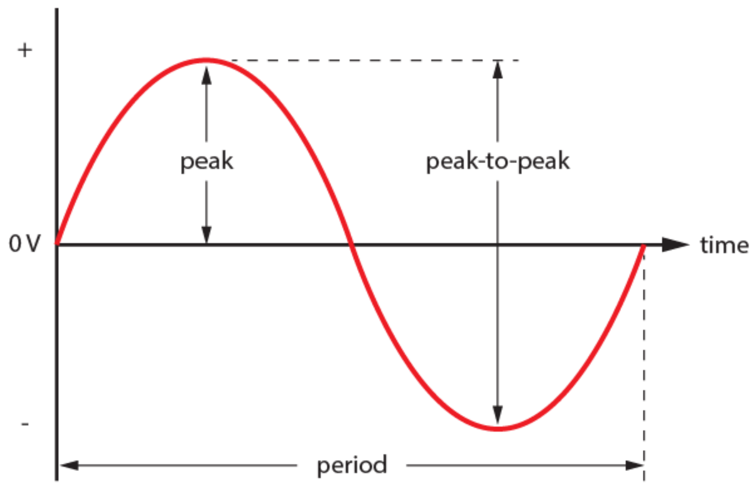

Figure 1

Topic Skills Practice 1.4

- Figure 2 shows an example of how to determine the peak-to-peak voltage, the period and the frequency of a sine wave. The procedure is:
    - To measure the voltage, count the number of divisions and subdivisions from the top of the waveform to the bottom. Multiply this by the volts/div. setting.
    - To measure the period, count the number of divisions and subdivisions from the left most zero crossing to the next zero crossing of the waveform where the wave starts to repeat itself. Multiply this by the sweep time/div. setting. (Note: you can also use any two similar points of the wave, such as the two adjacent peaks of the waveform).
    - To determine the frequency, divide the period into one (reciprocal of period).

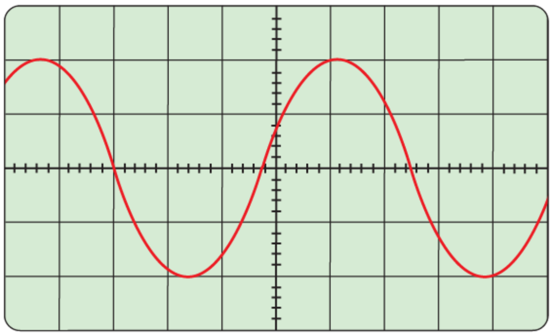

Figure 2. Measuring voltage and period using a CRO

Example:

If *volts/div.* setting is 2 V, then:

Volts peak-to-peak = 5 divisions x 2 = 10 V

If *sweep time/div.* setting is 50 µs, then:

Period (T) = 5.5 divisions x 50 µs = 275 µs

$$\text{Then as frequency is} = \frac{1}{T}$$

$$\text{Frequency (f)} = \frac{1}{275 \times 10^{-6}}$$

$$= 3.64 \text{ Hz}$$

Feedback — **Have your teacher/trainer check your work**	**Teacher/Trainer Initials and Date**	✓

Topic Skills Practice 1.4

2.2 Measure Frequency and Voltage

2.2.1 For the waveform you have displayed on the CRO, determine the peak to peak voltage, the period and the frequency. Enter these values in Table 1 (Note: the first row is shown as an example).

Table 1							
Frequency indicated on scale of signal generator	*Sweep time/div. setting on CRO*	*Width of waveform. Number of divisions*	*Measured period (T) of waveform*	*Calculated frequency of waveform (1/T)*	*Volts/div. setting of CRO*	*Height of waveform. Number of divisions*	*Measured voltage of waveform (Vp-p)*
1 kHz	*100 µs*	*9.9*	*990 µs*	*1010 Hz*	*5 V/div*	*1.4*	*7 Vp-p*
5 kHz							
10kHz							
100kHz							

2.2.2 Repeat step for function generator settings of 10 kHz at a quarter output and then 100 kHz at full output. Enter the results in Table 1.

2.2.3 Leave the function generator set to maximum output 100 kHz, but select a square wave output.

2.2.4 Adjust the CRO to obtain approximately one full cycle on the screen.

2.2.5 Using the same procedures described for the sine wave, measure the frequency and the peak-to-peak output voltage of the square wave.

2.2.6 Figure 3 shows how these measurements apply to a square wave. Record the readings and CRO settings in Table 2.

Topic Skills Practice 1.4

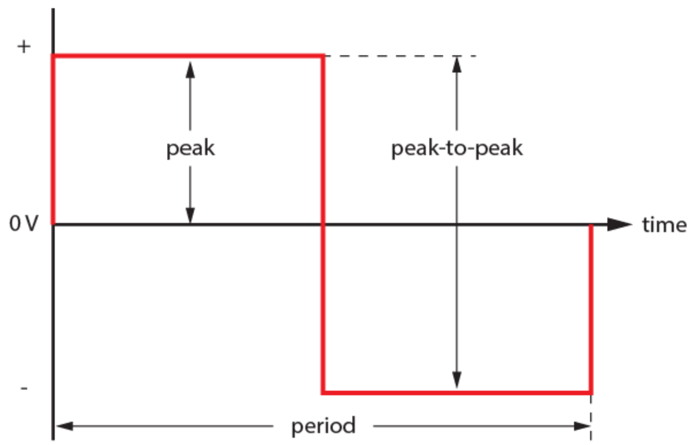

Figure 3

Table 2							
Frequency indicated on scale of signal generator	*Sweep time/div. setting on CRO*	*Width of waveform. Number of divisions*	*Measured period (T) of waveform*	*Calculated frequency of waveform (1/T)*	*Volts/div. setting of CRO*	*Height of waveform. Number of divisions*	*Measured voltage of waveform (Vp-p)*
100 kHz							
2 kHz							

2.2.7 Repeat step for function generator setting of 2 kHz at half output and record the results in Table 2.

2.2.8 Switch off the function generator and CRO and disconnect probes and leads.

	Feedback **Have your teacher/trainer check your work**	**Teacher/Trainer Initials and Date**	✓

Topic Skills Practice 1.4

3. Completing the Skills Practice

3.1 Skills Practice Review Questions

3.1.1 Clean your work area, return all equipment to the correct storage areas as directed by your teacher/trainer, and then complete the following questions.

1. A sine wave has a maximum voltage of 340 V and a frequency of 50 Hz. Determine the instantaneous values of voltage at the following points in the waveform. Show all working and provide your answers to three significant figures.

   a) 75^{o}

   b) 110^{o}

   c) 160^{o}

Answer (a): ____________ Answer (b): ____________ Answer (c): ____________

2. What is meant by the ‘period’ of a sinusoidal waveform?

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		Teacher/Trainer Initials and Date	
	Feedback Have your teacher/trainer check your answers		✓

Topic Skills Practice Cover Sheet

Unit Name:	UEEEL0020 Solve problems in low voltage a.c. circuits
Topic Title:	Power in an a.c. circuit

Skill Practice Number:	7.3
Skill Practice Name:	Single Phase Power Measurement

Student Name:	
Student ID:	
College/Campus:	
Group:	

Results	
Planning:	
Carryout:	
Completion:	
Overall Results:	
Comments:	

Topic Skills Practice 7.3

UEEEL0020 Solve problems in low voltage a.c. circuits

Topic 7. Power in an a.c. circuit

Skills Practice 7.3: Single phase power measurement

Task:

To measure the power in resistive, inductive and capacitive circuit connected to a single phase a.c. supply.

Objectives:

At the completion of this skills practice, you should be able to:

- Connect a wattmeter into a single phase circuit.
- Calculate the true power, apparent power and reactive power in a single phase circuit.
- Measure the true power, apparent power and reactive power in a single phase circuit.

Topic Skills Practice 7.3

1. Planning the Skills Practice

1.1 Equipment

- ELV a.c. supply
- Analogue multimeter
- Digital LCR meter
- Analogue voltmeter
- Wattmeter

1.2 Suggested Materials

- Resistor
- Capacitor
- Inductor

1.3 Miscellaneous Items

- Connection leads
- PPE
- Pens/pencils
- Ruler
- Calculator

1.4 Risk Assessment

Risk assessment procedure:

- Identify any hazards that may exist with this skills practice below
- List the supervision level you will be working under - Direct (D), General (G) or Broad (B)
- List the risk classification – High Risk (H), Medium Risk (M) or Low Risk (L)
- List the control measures required for each identified hazard that you need to implement.

Hazard/s Identified	Supervision Level (D, G or B)	Risk Classification (H, M or L)	Control Measure/s

Feedback	Have your teacher/trainer check your risk assessment	Teacher/Trainer Initials and Date	✓

Topic Skills Practice 7.3

2. Carrying Out the Skills Practice

2.1 Power in Resistive Circuits

2.1.1 Using the digital LCR meter, measure the value of the resistor, capacitor and inductor and record these values in Table 1.

Resistor - (R) *- ohms*	*Capacitor - (C)* *- uF*	*Inductor - L*	
		Inductance - mH	*Resistance - ohms*

Table 1

2.1.2 Connect up the circuit as shown in Figure 1 below.

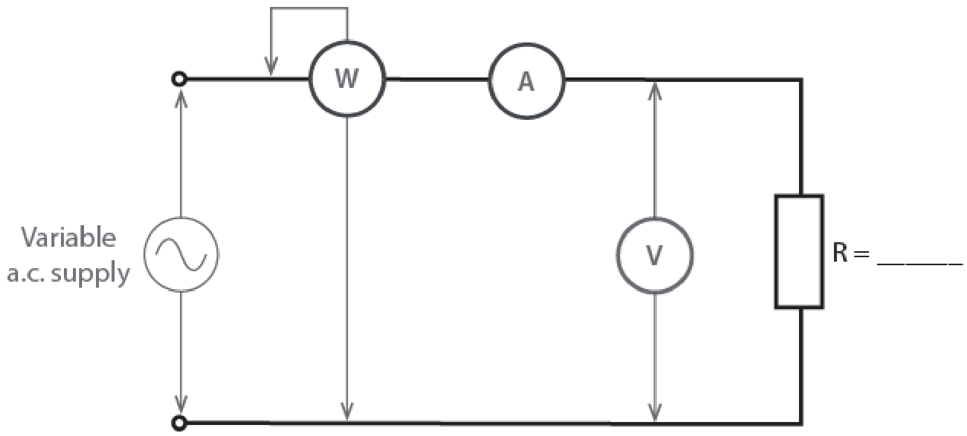


Figure 1

2.1.3 Turn the supply on, adjust the voltage to the value given by your teacher/trainer and record the wattmeter, voltmeter and ammeter readings in Table 2.

2.1.4 Using the values in Table 1 and 2, calculate the True Power, Apparent Power and Reactive Power and record in Table 3.

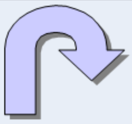
Wattmeter Reading *watts*	*Voltmeter Reading* *volts*	*Ammeter Reading* *amperes*

Topic Skills Practice 7.3

Table 2 – Measured

True Power (P) *P=I2R W*	*Apparent Power – (S)* *S = VI VA*	*Reactive Power – (Q)* *VAr*

Table 3 – Calculated

	 **Have your teacher/trainer check your work** ***Feedback***	**Teacher/Trainer Initials and Date**	✓

Topic Skills Practice 7.3

2.2 Power in Capacitive Circuits

2.2.1 Connect up the circuit as shown in Figure 2 below.

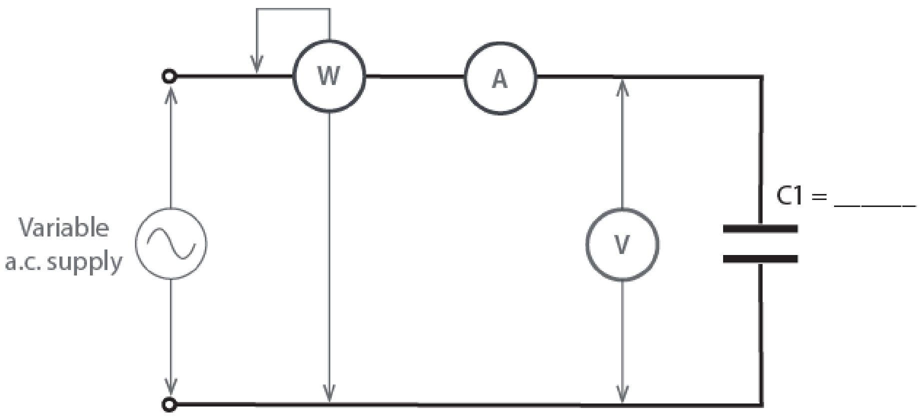


Figure 2

2.2.2 Turn the supply on, adjust the voltage to the value given by your teacher/trainer and record the wattmeter, voltmeter and ammeter readings in Table 4.

2.2.3 Using the values in Table 1 and 4, calculate the True Power, Apparent Power and Reactive Power and record in Table 5.

Wattmeter Reading ***watts***	***Voltmeter Reading*** ***volts***	***Ammeter Reading*** ***amperes***

Table 4 – Measured

True Power (P) ***P=I2R W***	***Apparent Power – (S)*** ***S = VI VA***	***Reactive Power – (Q)*** ***VAr***

Table 5 – Calculated

	Feedback **Have your teacher/trainer check your work**	**Teacher/Trainer Initials and Date**	✓

Topic Skills Practice 7.3

2.3 Power in Inductive Circuits

2.3.1 Connect up the circuit as shown in Figure 3 below:

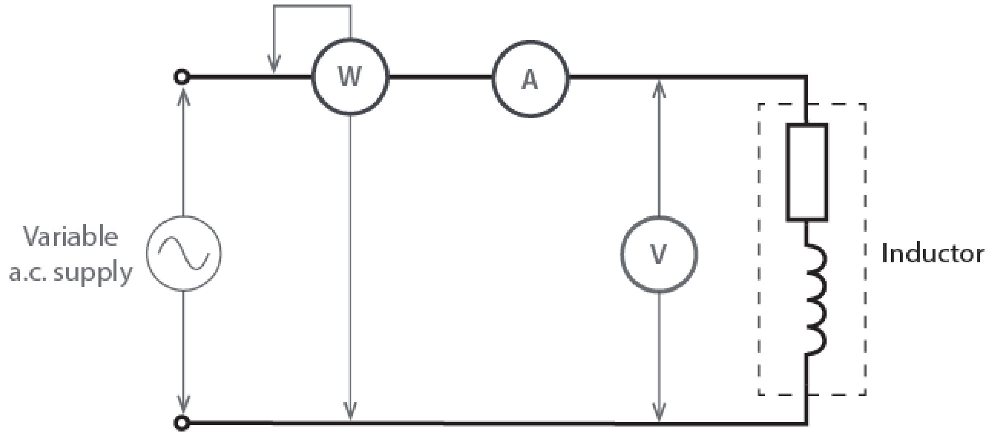


Figure 3

2.3.2 Turn the supply on, adjust the voltage to the value given by your teacher/trainer and record the wattmeter, voltmeter and ammeter readings in Table 6.

2.3.3 Using the values in Table 1 and 6, calculate the True Power, Apparent Power and Reactive Power and record in Table 7.

Wattmeter Reading ***watts***	***Voltmeter Reading*** ***volts***	***Ammeter Reading*** ***amperes***

Table 6 – Measured

True Power (P) ***$P=I^2R$ W***	***Apparent Power – (S)*** ***S = VI VA***	***Reactive Power – (Q)*** ***VAr***

Table 7 – Calculated

	Feedback — **Have your teacher/trainer check your answers**	**Teacher/Trainer Initials and Date**	✓

Topic Skills Practice 7.3

3. Completing the Skills Practice

3.1 Skills Practice Review Questions

3.1.1 Pack away the equipment and clean the area as instructed by your teacher/trainer. Then answer the following questions.

1. Why don’t capacitors and inductors consume power?

2. Explain the difference between true power and apparent power.

3. What is reactive power?

Topic Skills Practice 7.3

4. Using the results from Part 2.3 (Tables 6 and 7), draw the power triangle to represent the circuit and label each side.

	Feedback	**Have your teacher/trainer check your answers**	**Teacher/Trainer Initials and Date**	✓

Topic Skills Practice Cover Sheet

Unit Name:	UEEEL0020 Solve problems in low voltage a.c. circuits
Topic Title:	Energy and Power Requirements of a.c. Systems

Skill Practice Number:	13.3
Skill Practice Name:	Measure Three Phase Power

Student Name:	
Student ID:	
College/Campus:	
Group:	

Results	
Planning:	
Carryout:	
Completion:	
Overall Results:	
Comments:	

Topic Skills Practice 13.3

UEEEL0020 Solve problems in low voltage a.c. circuits

Topic 13. Energy and Power Requirements of a.c. Systems

Skills Practice 13.3: Measure Three Phase Power

Task:

To measure the power taken by a three phase motor when connected in star and delta.

Objectives:

At the completion of this skills practice, you should be able to:

- Connect up three phase loads and include wattmeters to measure the power
- Measure power in a balanced three phase circuit
- Use measured values of current, voltage and power to determine the power factor of a circuit
- Using manufacturers catalogues to select measurement equipment for a particular installation

Topic Skills Practice 13.3

1. Planning the Skills Practice

1.1 Equipment

- ELV a.c. supply
- Three phase induction motor
- Three pole switch
- Test equipment

1.2 Suggested Materials

- Two resistors $R_1 = R_2$
- Two wattmeters
- Two multimeters

1.3 Miscellaneous Items

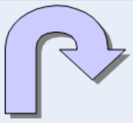
- Connecting leads
- PPE
- Pens/pencils
- Manufacturer's catalogues – metering and power factor correction

1.4 Risk Assessment

1.4.1 Risk assessment procedure:

- Identify any hazards that may exist with this skills practice below
- List the supervision level you will be working under - Direct (D), General (G) or Broad (B)
- List the risk classification – High Risk (H), Medium Risk (M) or Low Risk (L)
- List the control measures required for each identified hazard that you need to implement.

Hazard/s Identified	Supervision Level (D, G or B)	Risk Classification (H, M or L)	Control Measure/s

	 **Feedback**	**Have your teacher/trainer check your risk assessment**	**Teacher/Trainer Initials and Date**	✓

Topic Skills Practice 13.3

2. Carrying Out the Skills Practice

2.1 Connect the Motor in Star

2.1.1 Connect the circuit shown below in Figure 1:

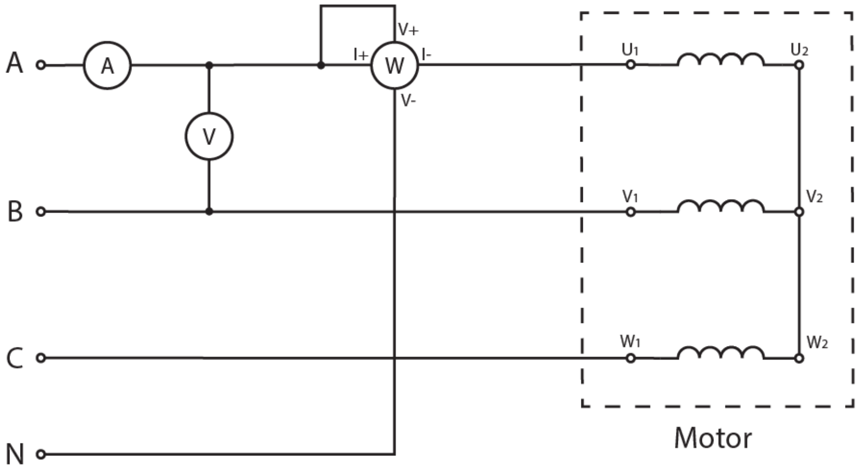


Figure 1

In this circuit:

- The motor windings are in star.
- The motor is connected to a three phase supply.
- A wattmeter and an ammeter are connected in A phase.
- A voltmeter is connected between A phase and B phase.

	 ***Feedback***	**Have your teacher/trainer check your work**	**Teacher/Trainer Initials and Date**	✓

2.2 Evaluate Star Connected Circuit Parameters

2.2.1 Turn on the supply to the motor, and record in Table 1 the line current, line voltage and the power as indicated by the meters.

2.2.2 Turn off the supply and reposition the meters to measure the line current and power in phase B and the voltage between phase B and phase C.

2.2.3 Turn on the supply and record the meter readings as shown in Table 1 on the following page.

Topic Skills Practice 13.3

2.2.4 Turn off the supply and reposition the meters to measure the line current and power in phase C and the voltage between phase C and phase A.

Table 1 – Measured Values – Star					
Line Current		**Line Voltage**		**Power**	
I_A	A	V_{A-B}	V	P_A	W
I_B	A	V_{B-C}	V	P_B	W
I_C	A	V_{A-C}	V	P_C	W

		Teacher/Trainer Initials and Date	
	Feedback — **Have your teacher/trainer check your work**		✓

2.3 Connect the Motor in Delta

2.3.1 Connect the circuit shown below in Figure 2:

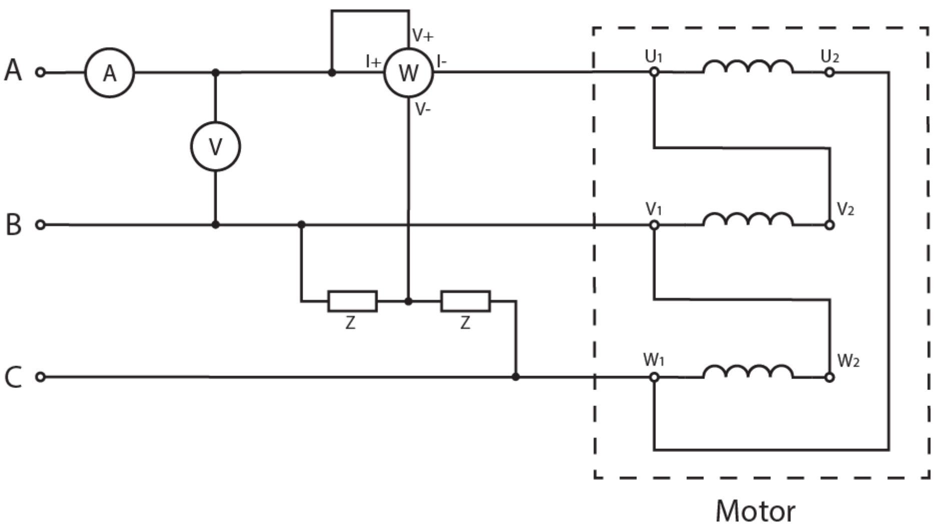


Figure 2

In this circuit:

- The motor windings are in delta.
- The motor is connected to a three phase supply.
- A wattmeter and an ammeter are connected in A phase.
- A voltmeter is connected between A phase and B phase.

Topic Skills Practice 13.3

2.3.2 Turn on the supply to the motor, and record the line current, line voltage and the power in Table 2.

2.3.3 Turn off the supply and reposition the meters to measure the line current and power in phase B and the voltage between phase B and phase C.

2.3.4 Turn on the supply and record the meter readings as shown in Table 2.

2.3.5 Turn off the supply and reposition the meters to measure the line current and power in phase C and the voltage between phase C and phase A.

2.3.6 Turn on the supply power and record the meter readings as shown in Table 2.

Table 2 – Measured Values – Delta					
Line Current		**Line Voltage**		**Power**	
I_A	A	V_{A-B}	V	P_A	W
I_B	A	V_{B-C}	V	P_B	W
I_C	A	V_{A-C}	V	P_C	W

2.3.7 Connect the circuit as shown in Figure 3 below, with the motor windings (three phase load) connected in delta.

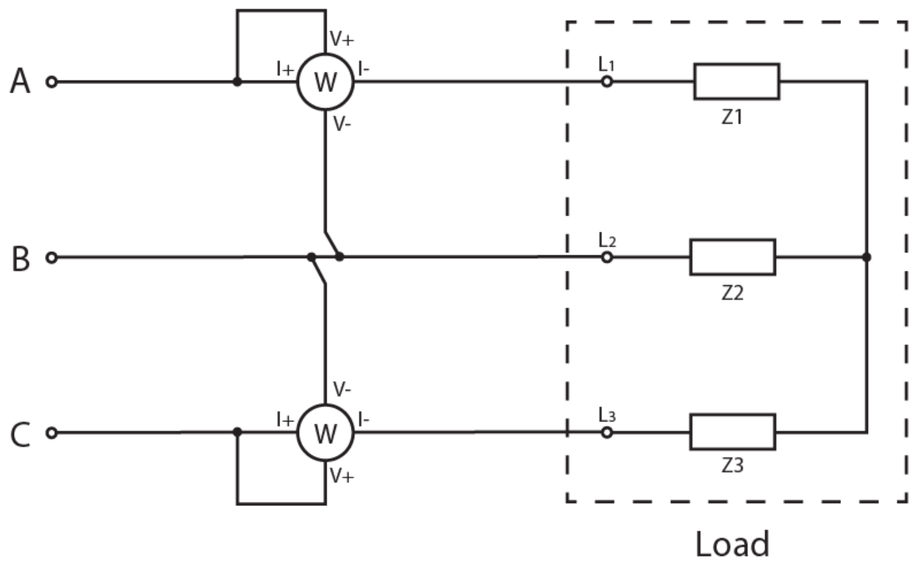
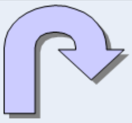


Figure 3

Topic Skills Practice 13.3

2.3.8 Measure the power using the two wattmeter method, and record your results in Table 3.

Table 3 – Two Wattmeter Method	
Wattmeter 1 (W_1)	**Wattmeter 2 (W_2)**

	 *Feedback* **Have your teacher/trainer check your work**	**Teacher/Trainer Initials and Date**	✓

3. Completing the Skills Practice

3.1 Skills Practice Observations

3.1.1 Clean your work area, return all equipment to the correct storage areas as directed by your teacher/trainer, and then complete the following questions.

1. Use the results obtained in Table 1 to calculate the apparent power, the true power and the power factor when the motor is connected in star where:

    - $S = (\sqrt{3})VI$
    - $P_T = P1 + P2 + P3$
    - $\lambda = P/S$

Apparent Power: ______________ True Power: ______________ Power Factor: ______________

Topic Skills Practice 13.3

2. Use the results obtained in Table 2 to calculate the apparent power, the true power and the power factor when the motor is connected in delta. Use the same equations stated in Question 1.

Apparent Power: ______________ True Power: ______________ Power Factor: ______________

3. Calculate the delta to star ratios for current, apparent power and true power.

Current Ratio: ____________________

True Power Ratio: ____________________

Apparent Power Ratio: ____________________

4. Use the results obtained in Table 3 to calculate the power factor of the motor when the motor was connected in delta and the power was measured with the two wattmeter method.

Power Factor: ____________________

Topic Skills Practice 13.3

5. Compare the power factor obtained in Question 2 to that obtained in Question 4. How similar are the two values?

6. Use manufacturer's catalogues to select appropriate power, energy and power factor metering equipment for a 10 kW, 400 V star-connected motor circuit. Indicate the makes, models and types of equipment selected.

7. Use manufacturer's catalogues to select appropriate power factor correction equipment for a 50 kW 400 V delta-connected motor circuit. Indicate the make, model and type of equipment selected.

	Feedback **Have your teacher/trainer check your answers**	**Teacher/Trainer Initials and Date**	✓

Topic Skills Practice Cover Sheet

Unit Name:	UEEEL0020 Solve problems in low voltage a.c. circuits
Topic Title:	Fault Loop Impedance

Skill Practice Number:	15.3
Skill Practice Name:	Measuring fault loop impedance

Student Name:	
Student ID:	
College/Campus:	
Group:	

Results	
Planning:	
Carryout:	
Completion:	
Overall Results:	
Comments:	

Topic Skills Practice 15.3

UEEEL0020 Solve problems in low voltage a.c. circuits

KE-UEEEL0020 Knowledge Evidence

Topic 15. Fault Loop Impedance

Skills Practice 15.3: Measuring fault loop impedance

Task:

To measure the earth fault loop impedance of a circuit and check its compliance with the Australian and New Zealand Standard AS/NZS 3000:2018.

Objectives:

At the completion of this skills practice, you should be able to:

- Measure the earth fault loop impedance of a circuit.
- Check a circuit's earth fault loop impedance compliance with the Australian and New Zealand Standard AS/NZS 3000:2018.

Topic Skills Practice 15.3

1. Planning the Skills Practice

1.1 Equipment

- RCD protected electrical circuit
- Low current earth fault loop impedance tester and connecting lead/probes

1.2 Suggested Materials

- AS/NZS 3000 (current edition)

1.3 Miscellaneous Items

- PPE
- Pens/pencils

1.4 Risk Assessment

Risk assessment procedure:

- Identify any hazards that may exist with this skills practice below
- List the supervision level you will be working under - Direct (D), General (G) or Broad (B)
- List the risk classification – High Risk (H), Medium Risk (M) or Low Risk (L)
- List the control measures required for each identified hazard that you need to implement.

Hazard/s Identified	Supervision Level (D, G or B)	Risk Classification (H, M or L)	Control Measure/s

	*Feedback* Have your teacher/trainer check your risk assessment	Teacher/Trainer Initials and Date	✓

Topic Skills Practice 15.3

2. Carrying Out the Skills Practice

2.1 Test Earth Fault Loop Impedance

2.1.1 Have your teacher/trainer identify a suitable RCD protected electrical circuit to conduct an earth fault impedance measurement.

2.1.2 Record the type and value of the circuit's RCD protection device in Table 1.

2.1.3 Use the appropriate table in the Australian and New Zealand Standard AS/NZS 3000:2018 to find the maximum allowable circuit resistance for the value and type of the circuit's RCD protection device. Record the result in Table 1.

2.1.4 Set the low current earth fault loop impedance tester to 'No Trip'.

2.1.5 Identify a suitable socket outlet and with the socket outlet switch turned off, plug the test instrument in.

		Teacher/Trainer Initials and Date	
	Have your teacher/trainer check your work *Feedback*		✓

2.1.6 Switch the socket outlet on and record the measured result in Table 1.

2.1.7 Switch off the socket outlet and disconnect the earth fault loop impedance tester.

RCD		***AS/NZS 3000:2018 maximum impedance for circuit***	***Measured impedance reading***
Type			
Value			

Table 1

		Teacher/Trainer Initials and Date	
	Have your teacher/trainer check your answers *Feedback*		✓

Topic Skills Practice 15.3

3. Completing the Skills Practice

3.1 Skills Practice Review Questions

3.1.1 Disconnect, pack away your equipment and clean the work area as instructed by your teacher/trainer. Then complete the following questions based on your observations.

1. Comparing all results from Table 1, is the earth fault loop impedance of the circuit within specification according to Australian and New Zealand Standard AS/NZS 3000?

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	Feedback	**Have your teacher/trainer check your answers**	**Teacher/Trainer Initials and Date**	✓