GOVERNMENT OF WESTERN AUSTRALIA

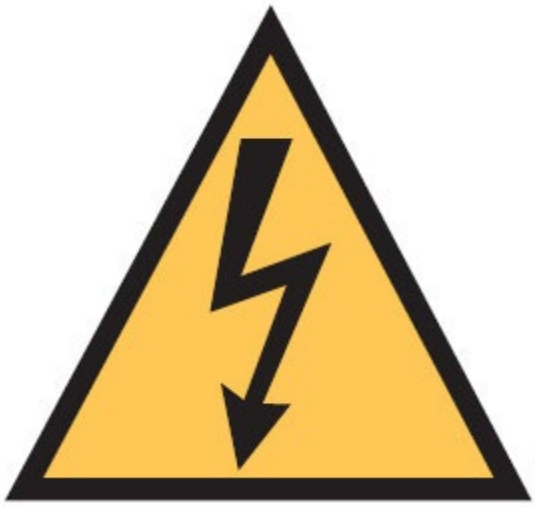
TAFE WA North Metropolitan

RTO Code: 52786

Portfolio of evidence

UEEEL0024

Test and connect alternating current (a.c.) rotating machines



UEE Training Package Support Material

Based on:
National Electrotechnology Industry Standards

GOVERNMENT OF WESTERN AUSTRALIA

TAFE WA North Metropolitan

Assessment Portfolio of Evidence

Qualification national code and title	UEE30820 Certificate III in Electrotechnology Electrician
Unit/s national code/s and title/s	UEEEL0024 - Test and connect alternating current (a.c.) rotating machines

North Metropolitan TAFE
V1 July 2022

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:

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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:

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.

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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.

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8. If the circuit is to be modified the student must:
   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	Name two types of typical 3 phase motors you may come across in industry?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 2	Name 4 <u>parts</u> you'll find in the construction of a 3 phase motor?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 3	What is the name given to the electromagnetic principle on which a three phase induction motor operates?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 4	Phase windings in a 3 phase motor are set how many degrees apart from each other?		
Answer	**A**	90°	
	B	180°	
	C	120°	
	D	270°	
Feedback			☐ Satisfactory ☐ Not satisfactory

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Question 5	A three-phase eight pole induction motor on load runs at 720 RPM when operating from a 50 Hz supply. Determine the motors: **a** synchronous speed **b** slip speed **c** percentage slip.	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 6	A two-pole 50 Hz three-phase induction motor is running at 2850 RPM. What is its rotor frequency?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 7	A three-phase motor connected to a supply with a line voltage of 400 V takes 6 A per phase at a power factor of 0.85. It delivers 21 Nm of torque at a speed of 1430 RPM. Calculate the efficiency of the motor.	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 8	Electrical energy supplied to the 3 phase stator winding produces a……..?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 9	A two pole, three-phase induction motor connected to a 50 Hz supply is running at a percentage slip of 4.5 per cent and delivers 40 Nm of torque. It has an efficiency of 89 per cent and a power factor of 0.9. Calculate the motors: **a** synchronous speed **b** slip speed **c** rotor speed **d** output power **e** input power **f** line current for a line voltage of 400 V.	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 10	A three-phase induction motor has a nameplate current of 65 A. What value of current should a thermal overload relay protecting the motor be set to?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 11	What are the two types of losses associated with running a 3 phase motor	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 12	What is the common name given to type of rotor you find within a 3 phase motor		
Answer	A	Squirrel Cage	
	B	Magnetic Cage	
	C	Mouse Cage	
	D	Stator Cage	
Feedback			☐ Satisfactory ☐ Not satisfactory

Question 13	Whats the main benefit of a wound rotor motor over a standard SCI motor	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 14	How can the speed be varied in a wound rotor motor	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 15	The international standard for identifying 3 phase terminals are?		
Answer		A1, B1, C1 A2, B2, C2,	
		U1 V1 W1 U2 V2 W2	
		X1 Y1 Z1 X2 Y2 Z2	
		1 2 3 4 5 6	
Feedback			☐ Satisfactory ☐ Not satisfactory

Question 16	A motor with a full-load torque of 150 Nm is started with a star–delta starter. What is its approximate starting torque?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 17	Complete the terminal diagram for a STAR configured 3phase circuit. Draw a circuit diagram of a typical star configuration	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 18	Complete the terminal diagram for a DELTA configured 3phase circuit. Draw a circuit diagram of a typical delta configuration	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 19	Why are the rotor bars in some squirrel cage induction motors 'skewed'?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 20	A conductor under a SOUTH magnetic pole has current flowing AWAY from the observer. Using Flemings Left hand rule determine the direction the conductor will tend to move?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 21	If a motor is internally connected in either Star or Delta how many terminal studs are required for the supply (not including the earth stud)		
Answer	**A**	6	
	B	3	
	C	4	
	D	5	
Feedback			☐ Satisfactory ☐ Not satisfactory

Question 22	The speed shown on the nameplate of a three phase motor is 1420 r/min. When would the speed of the motor be 1420 r/min?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 23	A three phase induction motor runs at just under 1500 r/min on no load. What would be the approximate no-load speed if the direction of rotation was reversed?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 24	If a wound rotor motor is running at full speed on full load, would the resistance of the rotor circuit be maximum or minimum?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 25	Name 4 bit of information you will see on a nameplate of a typical 3 phase motor?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 26	What are the possible causes for a motor overloaded	
Answer	**A**	Worn or tight bearings
	B	Short circuit in a winding
	C	Loose rotor bars
	D	All of the above
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 27	What are the three main aspects to consider when you have 3 phase motor failure?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 28	Will a three phase motor continue to run if one of the phases fail during operation?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 29	What is the minimum insulation resistance between motor phase windings you should read on your MEGGA	
Answer	**A**	0 ohms
	B	500 ohms
	C	1 Megohm
	D	0.5 ohms
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 30	True of False. Torque is proportional to the Voltage squared	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 31	What does the acronym MEPS stand for?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 32	What is the operational characteristic of the bi-metal strip in a thermal overload relay when the circuit becomes overloaded?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 33	List four types of overload protection device		
Answer	**A**		
	B		
	C		
	D		
Feedback			☐ Satisfactory ☐ Not satisfactory

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Question 34	Approximately how much current would a typical 20 amp three phase squirrel cage induction motor draw if it was started DOL?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 35	Under voltage protection is supplied by what type of relay	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 36	What type of overload relay is likely to have an oil dashpot mechanism	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 37	What type of over-temperature protection is embedded in the motor windings	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 38	How do you reverse the rotation of a 3 phase motor?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 39	AS/NZS 3000:2018 requires you to have motor overload protection with a motor rated at greater than……watts? State the clause number	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 40	True or False. A single phase motor produces a pulsating magnetic field that holds the rotor stationary	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 41	What is the only component in a split phase or capacitor start motor which can safely be connected so that it is in PARALLEL with the supply when the motor is running on full load		
Answer	**A**	Start winding	
	B	Start capacitor	
	C	Run winding	
	D	Centrifugal switch	
Feedback			☐ Satisfactory ☐ Not satisfactory

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Question 42	How many sets of windings does a split phase single phase motor have?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 43	A 230 V, 50 Hz six-pole split-phase motor has a rated speed of 960 RPM. Calculate the motor's (a) synchronous speed (b) slip speed (c) percentage slip?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 44	A split-phase motor operating from a 50 Hz supply has a percentage slip of 4.8%. What is the motor's rotor frequency?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 45	Which set of windings has the lower resistance?			
Answer	**A**	Start windings		
	B	Run windings		
	C	Primary windings		
	D	Secondary windings		
Feedback				☐ Satisfactory ☐ Not satisfactory

Question 46	What is the typical phase angle the run winding lags the start winding to create the small amount of torque to allow the initial rotation of the rotor.		
Answer			
Feedback			☐ Satisfactory ☐ Not satisfactory

Question 47	A single-phase motor takes a current of 5 A at a lagging power factor of 0.82 from a 230 V 50 Hz supply. How much true power is the motor consuming?		
Answer			
Feedback			☐ Satisfactory ☐ Not satisfactory

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Question 48	What is the main operating purpose of the centrifugal switch?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 49	At what percentage of rated speed does the centrifugal switch usually operate?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 50	A single-phase motor running at 1425 RPM takes 1050 W of true power when delivering a torque of 5.8 Nm. Calculate the motor's (a) output power (b) efficiency.	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 51	A single-phase 50 Hz, 230 V capacitor start motor has a 20 μF capacitor in series with its auxiliary winding. During starting, the main winding takes 2 A at a lagging power factor of 0.5, and the auxiliary winding takes 1.5 A at a leading power factor of 0.87. Determine the (a) phase difference between the currents in both windings (b) total current taken by the motor during starting (c) the voltage across the start capacitor during start-up	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 52	How do you reverse the direction of rotation of a typical split phase motor?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 53	What is the commonly used method for motor temperature control?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 54	What are the three main types of capacitor motors		
Answer	**A**	Capacitor start	
	B	Permanent split capacitor	
	C	Capacitor start, capacitor run	
	D	All of the above	
Feedback			☐ Satisfactory ☐ Not satisfactory

Question 55	What component is connected in series with the start winding in a split phase type motor?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 56	What is the name given to the speed of the 'rotating' magnetic field in an induction motor?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 57	What is the advantage of a capacitor start motor compared to a split phase motor of the same power rating?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 58	List 7 of the major components in a typical single phase split phase motor?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 59	Describe four faults which can occur in single phase split phase type motors. How can each of the faults be detected?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 60	What will happen to a split phase motor if the centrifugal switch fails to open after 10-30 seconds?			
Answer	**A**	Motor continues to run normally		
	B	The voltage in the motor doubles		
	C	The motors start winding will burn out		
	D	The motor frequency decrease		
Feedback				☐ Satisfactory ☐ Not satisfactory

Question 61	Which type of split phase motor has the greatest starting torque?		
Answer			
Feedback			☐ Satisfactory ☐ Not satisfactory

Question 62	What is the typical value of the start capacitor in micro-farads compared to the value in the run capacitor		
Answer			
Feedback			☐ Satisfactory ☐ Not satisfactory

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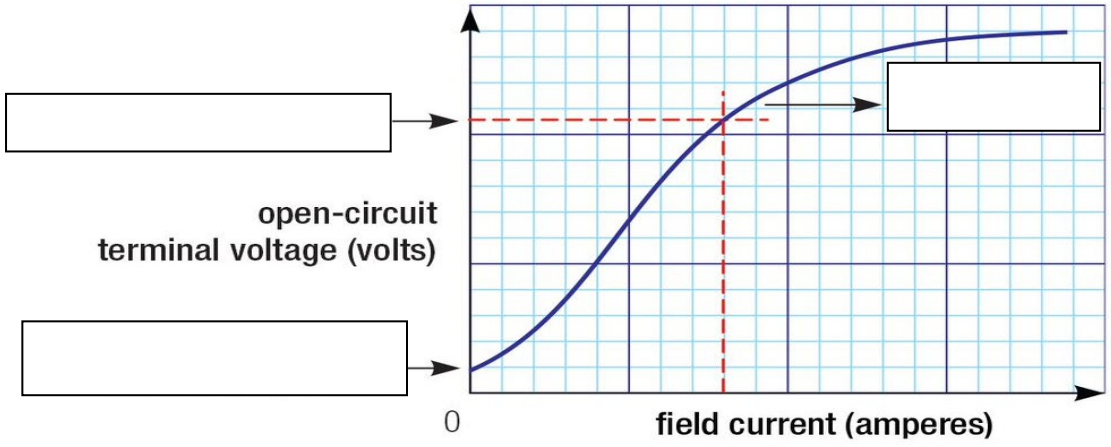
Question 63	Which of the following is the most suitable prime mover for a portable three phase alternator?	
Answer	• A steam turbine • A petrol or diesel internal combustion engine • A water turbine • A gas turbine	
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 64	In the diagram below, fill in the blanks, clearly showing the open-circuit characteristic curve of an alternator:	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 65	Can a split phase or capacitor start motor operate satisfactorily on a d.c. supply?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 66	What are the advantages to be gained by the parallel operation of alternators	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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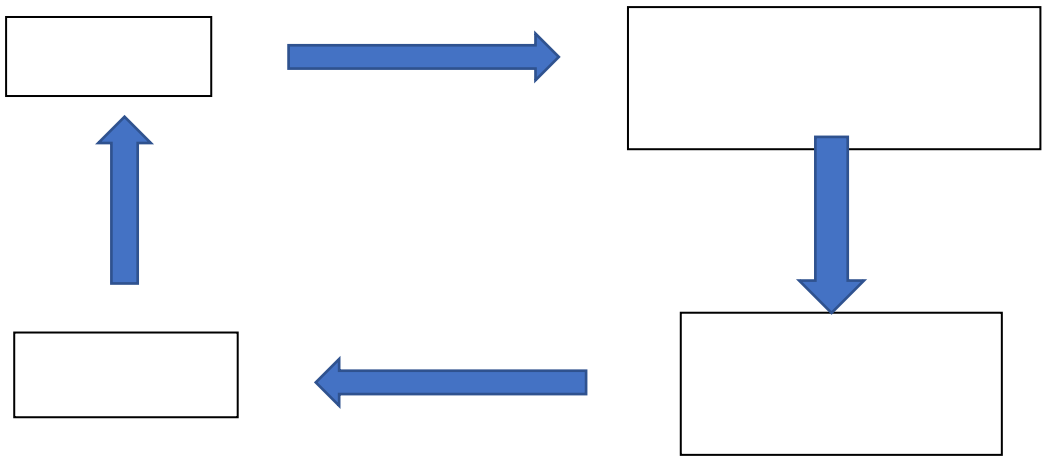
Question 67	Label the diagram below to indicate voltage control for an Alternator by placing the terms Alternator; Exciter and Voltage Regulator in the correct rectangle:	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 68	Name **six** (6) mechanical/electrical faults associated with **single** or **three** phase motors:	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 69	What applications are shaded-pole motors used for?		
Answer	**A**	Fans	
	B	Small motors	
	C	Clothes driers (for air circulation)	
	D	All of the above	
Feedback			☐ Satisfactory ☐ Not satisfactory

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Question 70	What will happen if a universal if it is disconnected from its load	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 71	What are the relevant AS/NZS 3000 standards relating to motor protection?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory
Question 72	A 20 amp three phase squirrel cage induction motor is to be installed with 20 amp copper cable and protected by HRC fuse. What is the largest HRC fuse which could be installed according to the Wiring Rules? Give the Clause number.	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 73	What is meant by the term 'single phasing' when applied to a three phase motor?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 74	A three-phase alternator is rated at 20 kVA at a full-load line voltage of 400 V. How much line current can the alternator supply?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 75	When does a universal motor have its maximum torque		
Answer	**A**	At full load	
	B	At start up	
	C	When the stator and rotor flux are maximum	
	D	All of the above	
Feedback			☐ Satisfactory ☐ Not satisfactory

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Question 76	The full-load terminal voltage of an alternator is 400 V, rising to 430 V when the load is disconnected. What is its percentage voltage regulation?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 77	Repetitive starting/reversing Q ??	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 78	An 8-pole synchronous motor is operating from a 50 Hz supply. What is its rotational speed?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 79	Need Q on : Clause 2.5.4 of the Wiring Rules specifies the requirements for protection against short circuit current. In general, protective devices must interrupt any short circuit current before the current can cause danger due to thermal and mechanical effects.	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 80	What is the synchronous speed of a 12-pole, 50 Hz alternator?	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 81	Principles of operation of an asynchronous generator are:		
Answer	**A**		
	B		
	C		
	D		
Feedback			☐ Satisfactory ☐ Not satisfactory

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Question 82	Name **five** (5) components which are included in the makeup of a single or three phase portable/standby alternator:	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

Question 83	Name **three** (3) common faults that can be found in portable/standby alternators:	
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

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Question 84		
Answer		
Feedback		☐ Satisfactory ☐ Not satisfactory

End of Theory Assessment

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Practical Activities Overview

1. Single Phase Transformer Connections

2. Develop, connect and test a single direct-on-line (DOL) magnetic starter circuit for a 415 volt three phase squirrel cage induction (SCI) motor.

3. Develop, connect and test a direct-on-line (DOL) magnetic starter circuit which controls a 415 volt three phase squirrel cage induction (SCI) motor from either of two stop-start stations.

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

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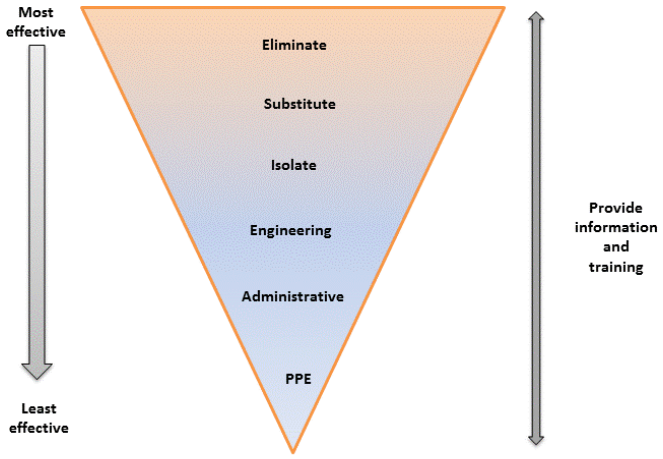
1. **Eliminate** – if it is possible, the hazard should be removed completely. For example, get rid of dangerous machines.
2. **Substitute** – replace something that produces the hazard with something that does not produce a hazard. For example, replacing solvent based paint with water based paint. Risk 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

Instructions

Procedure

DANGER TAG PROCEDURE MUST BE FOLLOWED

Three Phase SCI Motor Connections

Objective

To connect a three phase squirrel cage induction motor to the supply in STAR and DELTA and test it for correct operation in both directions.

Equipment

Three phase single speed squirrel cage induction motor up to about 3 kW that is able to be connection in both STAR and DELTA.
Multimeter.
Clip-on ammeter.
Connecting leads.
Three phase lead board.
Hand-held tachometer.

Procedure

DANGER TAG PROCEDURE REQUIRED

1. Examine the motor nameplate and record the following details:

Line Voltage		Power Rating	
Full Load Current		Number of Phases	
Full Load Speed		Connection	

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2. Draw a circuit diagram of a three phase six terminal squirrel cage induction motor connected in STAR, showing typical terminal markings.
Show the position of the incoming line connections.

3. Connect the motor in STAR at the terminal block and connect the three phase lead to it. Make sure that the earth is securely connected.

4. Check your wiring for short circuits using a multimeter set to the ohms x 1 range.
Check that the earth continuity to the motor is less than 1 ohm.

5. Have your connections checked by your Lecturer.

6. Switch the motor on and test it for correct operation. Record the no- load speed in the Results Table. Measure the current in each phase with a clip-on ammeter. Measure the rotor speed. Record the results.

7. Switch the motor off and remove the plug from the outlet.

8. Change your connections so that the motor will run in the opposite direction.

9. Check your wiring for short circuits using a multimeter set to the ohms x 1 range.
Check that the earth continuity to the motor is less than 1 ohm.

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10. Have your connections checked by your Lecturer.

11. Test the motor for correct operation. Measure the current in each phase with a clip-on ammeter. Measure the rotor speed. Record the results.

12. Repeat steps 2 to 11 with the motor connected in DELTA at the terminal block.

13. Switch the motor off and remove the plug from the outlet.

14. Have your results checked by your Lecturer.

15. Return all of the equipment to its proper place.

Results Table

	Speed	Line Current
STAR (forward)		
STAR (reverse)		
DELTA (forward)		
DELTA (reverse)		

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Questions

1. Does the measured speed correspond with the speed shown on the motor nameplate? If not, why?

2. Does the measured line current correspond with the current shown on the motor nameplate? If not, why?

3. Was there a significant difference between the speed in star and delta. If not, why?

4. Was there a significant difference between the speed in forward and the speed in reverse?

5. Is it permissible to wire up a three phase induction motor using the SAME active colour for each line conductor?

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Neat Pencil Sketch

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Practical Activity 2

Table 1

Split Phase Motor Connections

Objective

To connect a typical single speed single phase split phase induction motor to the supply and test it for correct operation.

Equipment

Typical single speed split phase motor project board.
Clip-on ammeter.
Multimeter.
Hand-held tachometer.
Single phase lead board.

Procedure

DANGER TAG PROCEDURE REQUIRED

1. Examine the motor nameplate and record the following details:

Line Voltage		Power Rating	
Full Load Current		Number of Phases	
Full Load Speed		Connection	

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2. Draw a circuit diagram of a single phase capacitor start motor connected to a 240 volt supply. Show the position of the incoming line connections. Have your circuit diagram checked by your Lecturer.

Circuit Diagram

3. Identify the terminals for the internal electrical components and record the resistance of each:

   a. The run winding.

   b. The start winding.

   c. The centrifugal-switch.

4. Connect the motor according to your diagram. Make sure that the earth is securely connected.

5. Check your wiring for short circuits using a multimeter set to the ohms x 1 range.
   Check the earth continuity to the motor is less than 1 ohm.

6. Have your connections checked by your Lecturer.

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7. Switch the motor on and test it for correct operation. Record the no-load speed in the Results Table. Measure the line current with a clip-on ammeter. Measure the rotor speed. Record the results.

8. Switch the motor off and remove the plug from the outlet.

9. Change your connections so that the motor will run in the opposite direction.

10. Check your wiring for short circuits using a multimeter set to the ohms x 1 range.
Check the earth continuity to the motor is less than 1 ohm.

11. Have your connections checked by your Lecturer.

12. Test the motor for correct operation. Measure the line current with a clip-on ammeter. Measure the rotor speed. Record the results.

13. Switch the motor off and remove the plug from the outlet.

14. Have your results checked by your Lecturer.

15. Return all of the equipment to its proper place.

Results Table

	No Load Speed	Line Current
Forward		
Reverse		

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Questions

1. Does the measured speed correspond with the speed shown on the motor nameplate? If not, why?

2. Does the measured line current correspond with the current shown on the motor nameplate? If not, why?

3. Was there a significant difference between the speed in forward and the speed in reverse?

4. What type of mechanism was used to disconnect the start winding in the motor used for this project?

5. Besides the type of starting mechanism in this motor, name another type of device used to disconnect the start windings in split-phase motors.

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Government of Western Australia North Metropolitan TAFE	**Solve problems in single phase and three phase low voltage machines**	Section 7 Activity Sheet 4	G006A SGB 12/2013

Practical Activity 3

Capacitor Start Motor Connections

Objective

To connect a typical single speed single phase capacitor start induction motor to the supply and test it for correct operation.

Equipment

Typical single speed capacitor-start motor project board.
Clip-on ammeter.
Multimeter.
Hand-held tachometer.
Single phase lead board.

Procedure

DANGER TAG PROCEDURE REQUIRED

1. Examine the motor nameplate and record the following details:

Line Voltage		Power Rating	
Number of Phases		Full Load Current	
Full Load Speed		Connection	

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2. Draw a circuit diagram of a single phase capacitor start motor connected to a 240 volt supply. Show the position of the incoming line connections. Have your circuit diagram checked by your Lecturer.

Circuit Diagram

3. Identify the terminals for the internal electrical components and record the resistance of each.

   a. The run winding.
   b. The start winding.
   c. The starting capacitor.
   d. The centrifugal switch.

4. Connect the motor according to your diagram. Make sure that the earth is securely connected.

5. Check your wiring for short circuits using a multimeter set to the ohms x 1 range. Check that the earth continuity is less than 1 ohm

6. Have your connections checked by your Lecturer.

7. Switch the motor on and test it for correct operation. Record the no- load speed in the Results Table. Measure the line current with a clip-on ammeter. Measure the rotor speed. Record the results.

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8. Switch the motor off and remove the plug from the outlet.

9. Change your connections so that the motor will run in the opposite direction.

10. Check your wiring for short circuits using a multimeter set to the ohms x 1 range.
Check that the earth continuity is less than 1 ohm

11. Have your connections checked by your Lecturer.

12. Test the motor for correct operation. Measure the line current with a clip-on ammeter. Measure the rotor speed. Record the results.

13. Switch the motor off and remove the plug from the outlet.

14. Record the capacity and voltage rating of the starting capacitor:

    Capacity: Voltage Rating:

15. Have your results checked by your Lecturer.

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16. Return all of the equipment to its proper place.

Results Table

	No Load Speed	Line Current
Forward		
Reverse		

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Questions

1. Does the measured speed correspond with the speed shown on the motor nameplate? If not, why?

2. Does the measured line current correspond with the current shown on the motor nameplate? If not, why?

3. Was there a significant difference between the speed in forward and the speed in reverse?

4. Explain the behaviour of the multimeter when testing the discharged capacitor for d.c. resistance.

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Practical Activity 4

Series Universal Motor Connections

Objective

To connect a typical series universal motor to the supply and test it for correct operation.

Equipment

Universal motor project board.
Clip-on ammeter.
Multimeter.
Hand-held tachometer.
Single phase lead board.
Single phase variable transformer (Variac)

Procedure

DANGER TAG PROCEDURE REQUIRED

1. Examine the motor nameplate and record the following details:

Line Voltage		Power Rating	
Full Load Current		Frequency	
Full Load Speed		Manufacturer	

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2. Draw a circuit diagram of the universal motor connected to a 240 volt supply. Show the position of the incoming line connections. Have your circuit diagram checked by your Lecturer.

Circuit Diagram

3. Identify the line terminals. Measure and record the d.c. resistance of the motor.

_____

4. Connect the motor according to your diagram. Make sure that the earth is securely connected. Make sure that the load is connected.

5. Check your wiring for short circuits using a multimeter set to the ohms x 1 range. Check that the earth continuity to the motor is less than 1 ohm.

6. Have your connections checked by your Lecturer.

7. Switch the motor on and test it for correct operation. Record the loaded speed in the Results Table. Measure the line current with a clip-on ammeter. Measure the rotor speed. Record the results.

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8. Switch the motor off and remove the plug from the outlet.

9. Change your connections so that the motor will run in the opposite direction.

10. Check your wiring for short circuits using a multimeter set to the ohms x 1 range.

11. Have your connections checked by your Lecturer.

12. Test the motor for correct operation. Measure the line current with a clip-on ammeter. Measure the rotor speed. Record the results.

13. Switch the motor off and remove the plug from the outlet.

14. Have your results checked by your Lecturer.

15. Return all of the equipment to its proper place.

Results Table

	On Load Speed	Line Current
Forward		
Reverse		

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Questions

1. Why is it dangerous to run a series motor on full voltage on no load?

2. Does the measured line current correspond with the currents shown on the motor nameplate? If not, why?

3. Was there a significant difference between the speed in forward and the speed in reverse?

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Practical Activity 5

Three Phase Induction Motor Construction

Objective

To identify the.major parts and features of a typical 415 volt three phase squirrel cage induction (SCI) motor.

Equipment

Three phase single speed squirrel cage induction motor up to about 5 kW.
Suitable parts tray.
Hand tools as required.
High voltage insulation tester.
Multimeter.
Suitable bearing pullers.
Felt tip marking pen.

Procedure

Note! Minor variations to this procedure may be necessary for different types of motor.

1. Make sure that the motor is not connected to the supply.

2. Examine the three phase squirrel cage induction motor provided and record all nameplate details. Record the general type of construction of the motor, and the intended mounting position (e.g. foot mounted or flange mounted).

Nameplate Details

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3. Mark the position of both end shields (and the cowling if fitted) in relation to the stator carcase using a felt pen. Use one line for the drive end and two lines for the non-drive end. Note that in industry it is common to mark the position of the end-shields with small centre punch marks.

4. Plan the job - decide on the general sequence in which the motor should be dismantled. If the bearings are of the ball or roller type with bolted bearing caps, the bearing caps should be removed first, otherwise the end shield retaining bolts should be removed first. All parts must be placed in a parts tray.

5. Carefully loosen both end shields and remove the non-drive end end-shield. Leave the drive-end end-shield on the bearing.

6. Withdraw the squirrel cage rotor, taking care not to allow it to touch the stator winding at any time (if you are not careful you. could damage the stator winding with the rotor or the shaft).

7. Remove the bearings from the shaft with a bearing puller.

8. Examine the parts of the motor and answer the following questions:

   a. What metal are the end shields made from?

   _____

   b. What type of fasteners are used to secure the end shields to the stator carcase (e.g. bolts, through bolts, socket-head screws)?

   _____

   c. What type of bearing is used on the drive end of the motor?

   _____

   d. What type of bearing is used on the non-drive end of the motor?

   _____

   e. What is the identification number on the drive-end bearing (if it is a ball or roller type)?

   _____

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f. What is the identification number on the non-drive-end bearing (if any)?

g. What type of material is the stator core made from?

h. What type of material is the rotor core made from?

i. What type of material is the rotor winding made from?

j. How many slots are there in the stator?

k. How many coils are there in the stator winding?

l. What material is the terminal block made from?

m. How many line terminals are there on the terminal block and how are they marked?

n. Is the motor designed for star or delta operation?

o. How many screws (or bolts) are used to retain the drive end bearing cap (if any)?

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p. What size is the conduit entry to the terminal box (if any)?

q. Where is the main cooling fan located?

r. Are the bearings the tightest fit on the shaft or in the end-shields?

s. Are the rotor bars parallel to the rotor shaft?

9. Draw a diagram of the motor terminal block, then measure and record the dc resistances between each pair of resistances.

10. Measure and record the, insulation resistance of the stator winding.

11. Re-assemble the motor taking care not to damage any components or force them into position.

12. Have your answers and results checked by your Lecturer.

13. Return all of the equipment to its proper place.

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Questions

1. Does a three phase squirrel cage induction motor require a neutral at the terminal block?

2. Refer to your results relating to the resistance between phases at the terminal block. Calculate the expected line current on 415 volts if the opposition to current flow was the value you measured (using Ohm's Law). Was the actual line current anywhere near your calculated value? If not, why not?

3. What is the minimum permissible insulation resistance for a three phase motor which is to be operated on a normal 415 volt three phase supply?

END OF PORTFOLIO OF EVIDENCE