basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

ELECTRICAL TECHNOLOGY (POWER SYSTEMS)

GUIDELINES FOR PRACTICAL ASSESSMENT TASKS

GRADE 12

2025

These guidelines consist of 48 pages.

TABLE OF CONTENTS

1. INTRODUCTION

The 18 Curriculum and Assessment Policy Statements subjects which contain a practical component all include a practical assessment task (PAT). These subjects are:

- AGRICULTURE: Agricultural Management Practices, Agricultural Technology
- ARTS: Dance Studies, Design, Dramatic Arts, Music, Visual Arts
- SCIENCES: Computer Applications Technology, Information Technology, Technical Sciences; Technical Mathematics
- SERVICES: Consumer Studies, Hospitality Studies, Tourism
- TECHNOLOGY: Civil Technology, Electrical Technology, Mechanical Technology and Engineering Graphics and Design

A practical assessment task (PAT) mark is a compulsory component of the final promotion mark for all candidates offering subjects that have a practical component and counts 25% (100 marks) of the end-of-the-year examination mark. The PAT is implemented across the first three terms of the school year. This is broken down into different phases or a series of smaller activities that make up the PAT. The PAT allows for learners to be assessed on a regular basis during the school year and it also allows for the assessment of skills that cannot be assessed in a written format, e.g. test or examination. It is therefore important that schools ensure that all learners complete the practical assessment tasks within the stipulated period to ensure that learners are resulted at the end of the school year. The planning and execution of the PAT differs from subject to subject.

Practical assessment tasks are designed to develop and demonstrate a learner's ability to integrate a variety of skills in order to solve a problem. The PAT also makes use of a technological process to inform the learner what steps needs to be followed to derive a solution for the problem.

The PAT consists of four simulations and a practical project. The teacher may choose any ONE of the practical projects and any TWO simulations available for POWER SYSTEMS. For the first simulation to be completed in term 1, the teacher must choose between Simulation 1 and Simulation 2. For Simulation 2 to be completed in term 2, the teacher must choose between Simulation 3 and Simulation 4.

The teacher must apply assessment on an ongoing basis at the same time that the learner is developing the required skills. TWO simulations should be completed by the learners, in addition to the manufacturing of a practical project.

The PAT incorporates all the skills the learner has developed throughout the year. The PAT ensures that all the different skills will be acquired by learners on completion of practical work, as well as the correct use of tools and instruments.

Requirements for presentation

A learner must present the following:

- PAT file with all the evidence of simulations, design and prototyping. A copy of the PAT 2025 cover page. The relevant simulations and assessment sheets should be copied and handed to each learner to include in the file.
- Practical project with:
  - Enclosure:
    - The file must include a design.
    - The enclosure and the design must match.
    - No cardboard boxes are allowed.
    - Plastic wooden and metal enclosures are acceptable.
    - Enclosures that are manufactured and/or assembled by the learners are preferred.
    - The enclosure should be accessible for scrutiny inside.
    - Lids that are secured are preferred.
  - Circuit board:
    - The file should include the PCB design.
    - The PCB must be mounted inside the enclosure in such a manner that it can be removed for scrutiny. Alternatively, inspection can be made from the bottom in cases where translucent (see-through) enclosures are used.
    - Switches, potentiometers, connectors and other items must be mounted.
    - Wiring must be neat and bound/wrapped.
    - Wiring must be long enough to allow for the PCB to be removed and inspected with ease.
  - Logo and name:
    - The file should contain the logo and name design and specification plate.
    - Logo, specification plate and name must be prominent on the enclosure.
    - The logo/specification plate must be affixed in a permanent manner – painted, glued or stuck on with vinyl.

The PAT will have a financial impact on the school's budget and school management teams are required to make provision for accommodating this particular expense.

PAT components and other items must be acquired timeously, for use by the learners, before the end of the first term at the start of the academic year.

It is the responsibility of the HOD to ensure that the teacher is making progress with the PAT from the start of the school year.

Provincial departments are responsible for setting up moderation timetables and consequently PATs should be completed by **31 August 2025**, in time for moderation.

2. TEACHER GUIDELINES

2.1 How to administer PATs

Teachers must ensure that learners complete the simulations required for each term. The project should be started in January in order to ensure its completion by August. In instances where formal assessments take place, the teacher has to assume the responsibility thereof.

The PAT should be completed during the FIRST THREE TERMS and must be ready at the start of PAT moderation. Teachers must make copies of the relevant simulations and hand them to learners at the beginning of each term.

The PAT must NOT be allowed to leave the workshop and must be kept in a safe place at all times when learners are not working on them.

The weightings of the PAT must be adhered to and teachers are not allowed to change weightings for the different sections.

2.2 How to mark/assess the PATs

The PAT for Grade 12 will be set and assessed internally, but moderated externally. All formal assessment will be done by the teacher.

The teacher is required to produce a working model and model answer file that sets the baseline for assessment at a Highly Competent Level for every project choice exercised by the learners. This file must include all the simulations with answers the teacher has done him/herself. The teacher will use the model answers and project to assess the simulations and projects of the learners.

Once a facet sheet has been completed by the teacher, assessment will be deemed to be complete. No reassessment will be done once the facet sheets have been completed and captured by the teacher. Learners must ensure that the work is done to the required standard before the teacher finally assesses the PAT during each stage of completion.

2.3 PAT Programme of Assessment (PAT PoA)

The programme of assessment (PoA) of the PAT is as follows:

TIME FRAME	ACTIVITY	RESPONSIBILITY
	Preparation for PAT 2025	Teacher – Builds the models and works out the model answers for the simulations. Identifies shortages in tools, equipment and consumable items for simulations that must be procured. SMT – Receives procurement requests from teachers and processes payments for the acquisition of required items
January–March 2025	Simulation 1	Teacher – Copies and hands out simulations Learners – Complete simulations Teacher – Assesses simulations HOD – Checks if tasks have been completed and marked by the teacher before the holidays
January 2025	PAT project – procurement	Teacher – Obtains quotations for PAT projects Principal – Approves PAT procurement for PAT projects Teacher – Ensures that PAT projects are ordered and delivered HOD – Checks that all tasks are completed and marked by the teacher before the holidays
February- March 2025	PAT project – learners commence with project	Teacher – Ensures that there is secure storage for PAT projects Teacher – Hands out and takes in PAT projects Teacher – Hands out copies of Section B, Design and Make: Part 1 Teacher – Includes practical sessions for learners to complete the PAT project every week Learners - Insert copies of Section B, Design and Make: Part 1 in the PAT file. Complete Section B, Design and Make: Part 1 (Circuit diagram, component list, Description of operation). Teacher – Assesses Section B, Design and Make: Part 1 HOD – Checks in on teacher to ensure that practical workshop sessions take place on a weekly basis
April–June 2025	Simulation 2	Teacher – Copies and hands out simulations Learners – Complete simulations Teacher – Assesses simulations Learners – Complete Section B, Design and Make: Part 1 (Circuit Board Manufacturing) Teacher – Assesses Section B, Design and Make: Part 1 HOD – Checks if tasks have been completed and marked by the teacher before the holidays
April–June 2025	Moderation of Simulation 1	District subject facilitator/subject specialist will visit the school and moderate Simulation 1 10% of learners' work is moderated
April–June 2025	PAT project – learners continue with project	Teacher – Includes practical sessions every week for learners to complete the PAT project Learners – Continue with completion of the PAT project HOD – Checks in on teacher to ensure that practical workshop sessions take place on a weekly basis
July holidays 2025	PAT intervention	Learners that are behind on the PAT are required to complete the project during these holidays
July–August 2025	Moderation of Simulation 2	District subject facilitator/subject specialist will visit the school and moderate Simulation 2 – different learners from the previous term 10% of learners' work is moderated

TIME FRAME	ACTIVITY	RESPONSIBILITY
July–August 2025	PAT project – completion	Teacher – Ensures that there is secure storage for PAT projects Teacher – Hands out Section B, Design and Make: Part 2 Learners – Insert copies of Section B, Design and Make: Part 2 in the PAT file; complete Section B, Design and Make: Part 2 Teacher – Assesses Section B, Design and Make: Part 2. Transfer marks onto working marksheet HOD – Checks to see that 100% of the PAT files and projects are completed and assessed
September 2025	PAT moderation	PAT projects are moderated by subject facilitators/subject specialists from the province and learners are available to demonstrate skills 10% of learners are moderated randomly
October 2025	PAT moderation	PAT projects and simulations are moderated by subject specialists from DBE and learners are available to demonstrate skills Learners are moderated randomly

2.4 Moderation of PATs

Provincial moderation of each term's simulations will start as early as the following term. Simulation 1 should be moderated as soon as the second term starts. Similarly, Simulation 2 will be moderated in July. The project will, however, only be moderated on completion.

During moderation of the PAT, the learner's file and project must be presented to the moderator.

The moderation process is as follows:

- During moderation, learners are randomly selected to demonstrate the different simulations. All four simulations will be moderated.
- The teacher is required to build an exemplar model of each project type chosen for the school.
- This model must be on display during moderation.
- The teacher's model forms the standard of the moderation at Level 4 (Highly Competent).
- Level 5 assessments must exceed the model of the teacher in skill and finishing.
- Learners who are moderated will have access to their files during moderation and may refer to the simulations they completed earlier in the year.
- Learners may NOT ask assistance from other learners during moderation.
- All projects and files must be on display for the moderator.
- If a learner is unable to repeat the simulation or cannot produce a working circuit during moderation, marks will be deducted and circuits assessed as not being operational.
- The moderator will randomly select no fewer than two projects (not simulations) and the learners involved will have to explain how the project was manufactured.
- Where required, the moderator should be able to call on the learner to explain the function and principles of operation, and request the learner to exhibit the skills acquired through the simulations for moderation purposes.
- On completion the moderator will, if needed, adjust the marks of the group upwards or downwards, depending on the outcome of moderation.
- Normal examination protocols for appeals will be adhered to if a dispute arises from adjustments made.

2.5 Absence/Non-submission of tasks

The absence of a PAT mark in Electrical Technology without a valid reason: The learner will be given three weeks before the commencement of the final end-of-year examination to submit the outstanding task. Should the learner fail to fulfil the outstanding PAT requirement, such a learner will be awarded a zero (0) for that PAT component.

2.6 Simulations

Simulations are circuits, experiments and tests/tasks which the learner will have to build, test and measure and practically do as part of the development of practical skills. These skills have to be illustrated to the external moderator that visits the school at intervals during the school year.

Teachers who make use of simulation programs on a computer may use them for the learners to practise on. However, it is required that the circuit be built using real components and that measurements be made with actual instruments for the purposes of assessment and moderation.

The correct procedure for completing simulations is outlined below for teachers and school management teams who are responsible for the implementation of the PAT in Electrical Technology.

STEP 1: The teacher will choose simulations from simulations that are provided.
STEP 2: Compile a list of the components needed for every simulation. Add extra components as these items are very small and you will need extras, as these items get lost/damaged very easily when learners work on them.
STEP 3: Contact three different electronics component suppliers for comparative quotations.
STEP 4: Submit the quotations to the SMT for approval and procurement of the items.
STEP 5: Place the components in storage. Collate items for each simulation, thus making it easier to distribute and use during practical sessions. Ensure that different values of components do not mix, as this would lead to components being used incorrectly and this could damage the component and in extreme cases, the equipment used.
STEP 6: Copy the relevant simulations and hand them out to learners at the start of the term.

Teachers are allowed to adjust circuits and component values to suit their environment/resource availability.

Teachers are required to develop a set of model answers in the teacher's file. Moderators will use the teacher's model answers and artefacts when moderating.

2.7 Projects

The projects are construction projects teachers can choose for their learners. These projects are based on proven circuits provided by schools and subject advisors. The projects are based on working prototypes and require careful construction in order for it to operate correctly.

Projects vary in cost and teachers must ensure that the projects chosen to fall within the scope of the school's budget.

Once the teacher has decided on a circuit, he/she must construct the prototype. Thereafter, copies of the provided circuit can be made and distributed to learners. They MUST redraw these circuits in their files correctly.

The description of the operation of the circuits is NOT complete. Learners are required to interrogate the function of the components in the circuit provided. Learners should elaborate on the purpose of components in the circuit. It is recommended that learners investigate similar circuits available on the internet and in the school library or workshop reference books.

2.8 Working mark sheet

(A working Excel file is provided with this PAT.)

PAT mark sheet		Term 1	Term 2	Project		Total = Term 1 + Term 2 + Project	Mark out of 100	Moderated Mark
No.	Name of Learner	Simulation 1 or 2 50	Simulation 3 or 4 50	Design and Make Part 1 120	Design and Make Part 2 30	250		
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								
12.								
13.								
14.								
15.								
	Total							
	Average							

Teacher Name: _____ Principal Name: _____ Moderator Name: _____

Signature: _____ Signature: _____ Signature: _____

Date: _____ Date:_____ Date:_____

3. LEARNER GUIDELINES

3.1 PAT 2025 COVER PAGE

(Place this page at the front of the PAT.)

Department of Basic Education Grade 12
CAPS for Technical High Schools Practical Assessment Task – Electrical Technology

Time allowed: Terms 1–3 (2025)

Learner Name: _____

Class: _____

School: _____

Specialisation: POWER SYSTEMS

Complete Simulation 1 or 2 in the FIRST TERM, and Simulation 3 or 4 in the SECOND TERM.

Project (Write the name of the project): _____

Evidence of moderation:

NOTE:
When the learner evidence selected has been moderated at school level, the table will contain evidence of moderation. Provincial moderators will sign the provincial moderation and only sign if re-moderation is needed.

Moderation	Signature	Date	Signature	Date
School-based				
District moderation				
Provincial moderation			Re-moderation	

Mark allocation

PAT Component	Maximum Mark	Learner Mark	Moderated Mark
Simulation for Term 1	50		
Simulation for Term 2	50		
Design and Make Project – Circuit	120		
Design and Make Project – Enclosure	30		
Total	**250**		

3.2 Instructions to the learner

- The practical assessment task counts 25% of your final promotion mark.
- All work produced by you must be your own effort. Group work and co-operative work are NOT allowed.
- The practical assessment task must be completed over three terms.
- The PAT file must contain TWO simulations and a practical project.
- Calculations should be clear and include units. Calculations should be rounded off to TWO decimals. SI units should be used.
- Circuit diagrams can be hand-drawn or drawn on CAD. NO photocopies or scanned files are allowed.
- Photos are allowed and may be in colour or greyscale. Scanned photos and photocopies are allowed.
- This document must be placed inside your PAT file together with the other evidence.
- Learners with identical photos will be penalised and receive zero for that section.

3.3 Declaration of Authenticity (COMPULSORY)

Declaration:

I _____ (name) herewith declare that the work represented in this evidence is entirely my own effort. I understand that if proven otherwise, my final results may be withheld.

_____ _____
Signature of learner Date

4. SIMULATIONS

4.1 RLC series circuit

Name of learner: _____	
Class: _____ Date completed: _____	Mark _____ **50**
Date Assessed: _____ Assessor Signature: _____	
Date Moderated: _____ Moderator Signature: _____	

4.1.1 Purpose:

- To build an RLC series circuit
- To compare the voltage drops across the components with a change in frequency in a RLC series circuit

4.1.2 Required resources:

TOOLS/INSTRUMENTS	MATERIALS
Function generator Experiment board Connecting wires 1 x multimeter Oscilloscope (dual channel)	1 mH inductor 1 µF capacitor (non-polarised) 1 kΩ (brown, black, red 5% - ½ Watt)

4.1.3 Procedure:

- Build the RLC series circuit in FIGURE 4.1.3 (see next page) on the breadboard using the components provided.
- Set the function generator to a sine wave and adjust the voltage to 5 V_{PK}. (Set the voltage as high as the function generator allows)
  NOTE: Once the voltage is set, do NOT change the amplitude of the voltage.
- Set the frequency to 100 Hz.
- Take the voltage measurements with a multimeter and record your findings. (If your multimeter cannot measure the required voltage at the set frequency, use the oscilloscope measurements. Please DO NOT mix the measurements as the multimeter measures rms-values and the oscilloscope displays peak values.)
- Draw the voltage waveforms across the resistor and the total voltage across all three components on the oscillograph.
- Do calculations as required.
- Draw the corresponding phasor diagram.
- Repeat the steps as required.

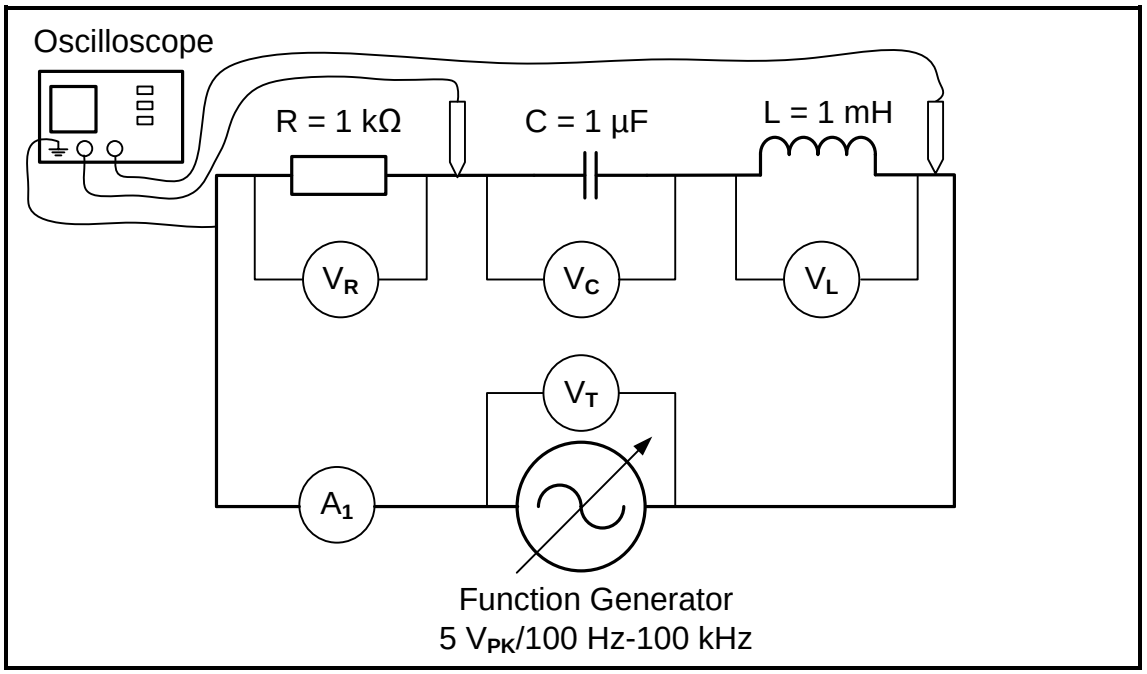


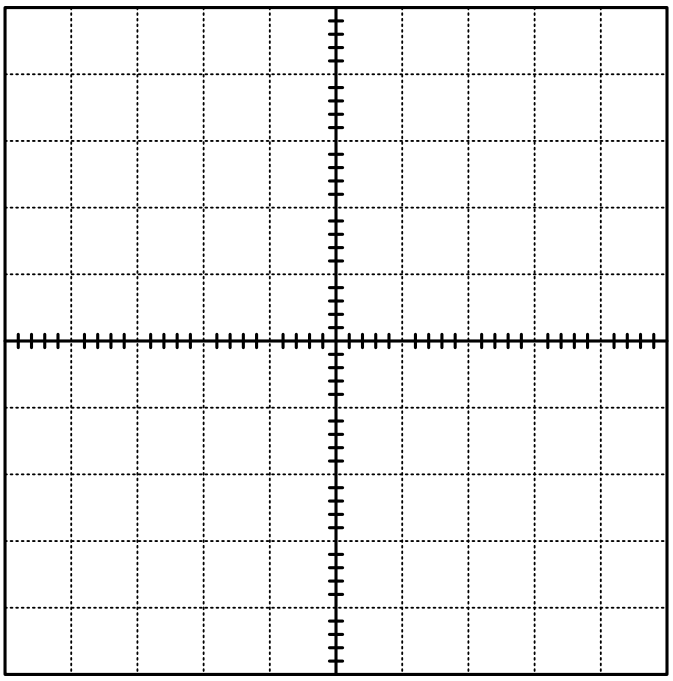
FIGURE 4.1.3

4.1.4 Use a multimeter to record the following:

f (Hz)	V_R	V_T
100 Hz		

TABLE 4.1.4 (2)

4.1.5 Connect the oscilloscope with the probe of channel 1 across the resistor and channel 2 across all components (supply) and draw the waveforms below.



CH 1 V/div: _____

CH 2 V/div: _____

Time/div: _____

$V_{R(PK)}$:_____

$V_{T(PK)}$:_____

FIGURE 4.1.5: OSCILLOGRAPH

NOTE: 2 marks for each correct waveform = 4
1 mark for each oscilloscope setting = 3 (7)

4.1.6 Calculate the phase angle by using the voltage values measured in TABLE 4.1.4.

_____

_____

_____

_____

_____

(3)

4.1.7 Draw a phasor diagram by using the voltage values measured in TABLE 4.1.4 and the phase angle calculated in QUESTION 4.1.6.

(4)

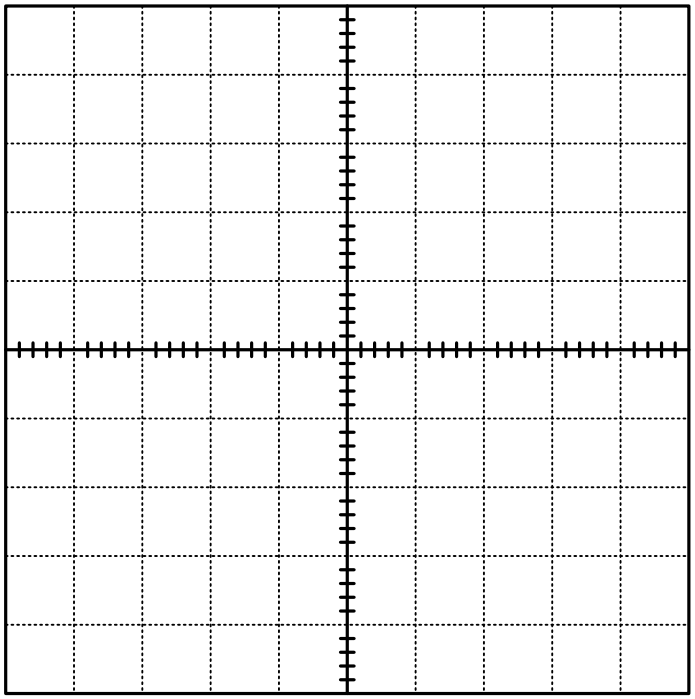
4.1.8 Adjust the frequency to 5 kHz and use a multimeter to record the following:

	V_R	V_T
5 kHz		

TABEL 4.1.8

(2)

4.1.9 Connect the oscilloscope with the probe of channel 1 across the resistor and channel 2 across all components (supply) and draw the waveform.



CH 1 V/div: _____

CH 2 V/div: _____

Time/div: _____

$V_{R(PK)}$:_____

$V_{T(PK)}$:_____

FIGURE 4.1.9: OSCILLOGRAM

NOTE: 2 marks for each correct waveform = 4
1 mark for each oscilloscope settings = 3 (7)

4.1.10 Adjust the frequency to 100 kHz and use a multimeter to record the following:

	V_R	V_T
100 kHz		

TABLE 4.1.10 (2)

4.1.11 Calculate the phase angle by using the voltage values measured in TABLE 4.1.10.

_____

_____

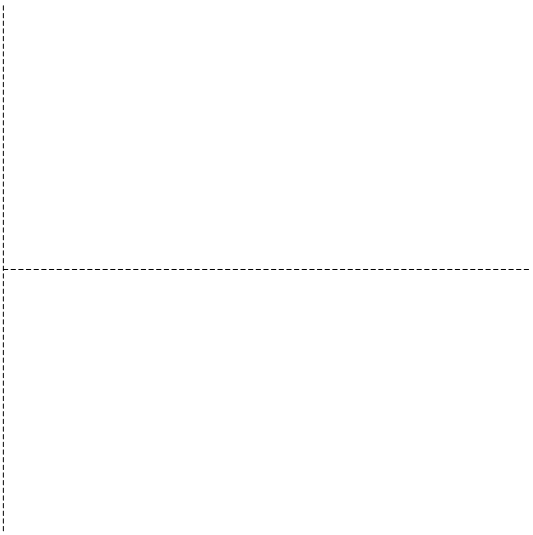
_____

_____

_____

(3)

4.1.12 Draw a phasor diagram by using the voltage values measured in TABLE 4.1.10 and the phase angle calculated in QUESTION 4.1.11.



(4)

4.1.13 Compare the voltage waveform across the resistor and the supply voltage with the frequency set to 100 Hz in FIGURE 4.1.5. State whether I_T is leading or lagging V_T and motivate your answer.

_____

_____

_____

_____

_____

(2)

4.14 Compare the voltage waveform across the resistor and the supply voltage with the frequency set to 100 kHz in FIGURE 4.1.9. State whether I_T is leading or lagging versus V_T and motivate your answer.

_____

_____

_____

(2)

4.15 Explain the significance of setting the frequency to 5 kHz.

_____

_____

_____ (2)
(40)

NOTE: Learner competency in this context will mean the following:
(This is done for easy assessment when using a rubric.)

Not yet competent	Have not met the requirements and will be given another opportunity for re-assessment. • Be precise about what they did wrong, or the areas they need to improve in. • Clearly explain the level of skill they need to achieve to be assessed as 'competent'. • Indicate whether part or all the assessment events will need to be repeated.
Competent	Have the necessary ability, knowledge, or skill to complete the task successfully. • Acceptable and satisfactory, though not outstanding.
Outstanding	Went beyond expectation (neatness, proficiency – high degree of skills, expertise)

FACET SHEET FOR SIMULATION 1

Task description	Mark allocation (tick the appropriate level next to the task indicated)				Allocation of marks
	Competent after reassessment of certain/all parts of the task	**Not yet competent after reassessment of certain/ all parts of the task**	**Competent**	**Outstanding (Highly competent)**	
Building the RLC circuit	The learner was given opportunities to rebuild the circuit after the teacher intervened in identifying and rectifying mistakes. **(1)**	The learner was given an opportunity to rebuild part of the circuit after the teacher intervened in identifying and rectifying a few mistakes. **(2–3)**	The learner correctly built the circuit without the guidance of the teacher. **(4–5)**	The learner correctly built the circuit without the guidance of the teacher and went beyond expectations and with high proficiency. **(6)**	$\overline{6}$
Safety aspects	The learner was timeously reminded to apply safety rules, regulation and correct procedure when using tools and instruments. **(0)**	The learner was sometimes reminded to apply safety rules, regulation and correct procedure when using tools and instruments. **(1)**	The learner applied safety rules, regulation and correct procedure when using tools and instruments to wire the circuits without being reminded by the teacher. **(2)**		$\overline{2}$
Attitude/ Behaviour/ Conduct	The learner was reluctant to work, cooperate, take responsibility of their own conduct and follow instructional, regulation and workshop practice even after being cautioned/reprimanded. **(0)**	The learner was reluctant to a certain degree to work, cooperate, take responsibility of their own conduct and follow instructional, regulation and workshop practice. **(1)**	The learner demonstrated willingness to work, cooperate, take responsibility of their own conduct and follow instructional, regulation and workshop practice. **(2)**		$\overline{2}$
				Rubric	$\overline{\mathbf{10}}$
				Theory	$+\ \overline{\mathbf{40}}$
				Total Simulation 1	$=\ \overline{\mathbf{50}}$

4.2 Simulation 2: Three-phase AC generation

Name of learner: _____	
Class: _____ Date completed: _____	Mark _____ **50**
Date Assessed: _____ Assessor Signature: _____	
Date Moderated: _____ Moderator Signature: _____	

4.2.1 Purpose:

To power three single-phase loads from a three-phase supply and investigate the current flowing in the neutral conductor when the load is balanced vs when the load is unbalanced

4.2.2 Required resources:

TOOLS/INSTRUMENTS	MATERIALS
Three-phase AC supply Multimeter Clamp-on ammeter (or panel ammeters)	Insulated wires (min 2,5 mm^2) Male and female banana terminals Three single-phase supply boxes Separate live, neutral and earth wires to allow current measurements in each conductor Three single-phase socket outlets Three identical single-phase loads – preferably resistive (same watt output) One larger single-phase load – preferably resistive (at least double or half the output in watt compared to the identical loads)

4.2.3 Procedure:

- Build the circuit in FIGURE 4.2.3 on the panel using the components provided.
- The teacher should ensure that the panels used are safe for learners with no exposed live terminals as three-phase power is dangerous.
- All connectors and connecting points MUST be insulated.
- It is recommended that ALL wiring and connectors are made up of insulated wires, using the male and female banana socket system.
- All wires must have the correct current rating to power the loads connected.
- The teacher must ensure that ALL wiring is correct before the power is switched ON.
- Take extreme care when using measuring instruments that no wire is disconnected or removed from the circuit while power is ON.
- It is recommended that a digital clamp-on ammeter and a digital multimeter are used.
- Ensure that the loads connected are big enough to indicate a current reading (LED lights will not be sufficient).
- Wattage per single-phase load should be between 100 W and 1 000 W.

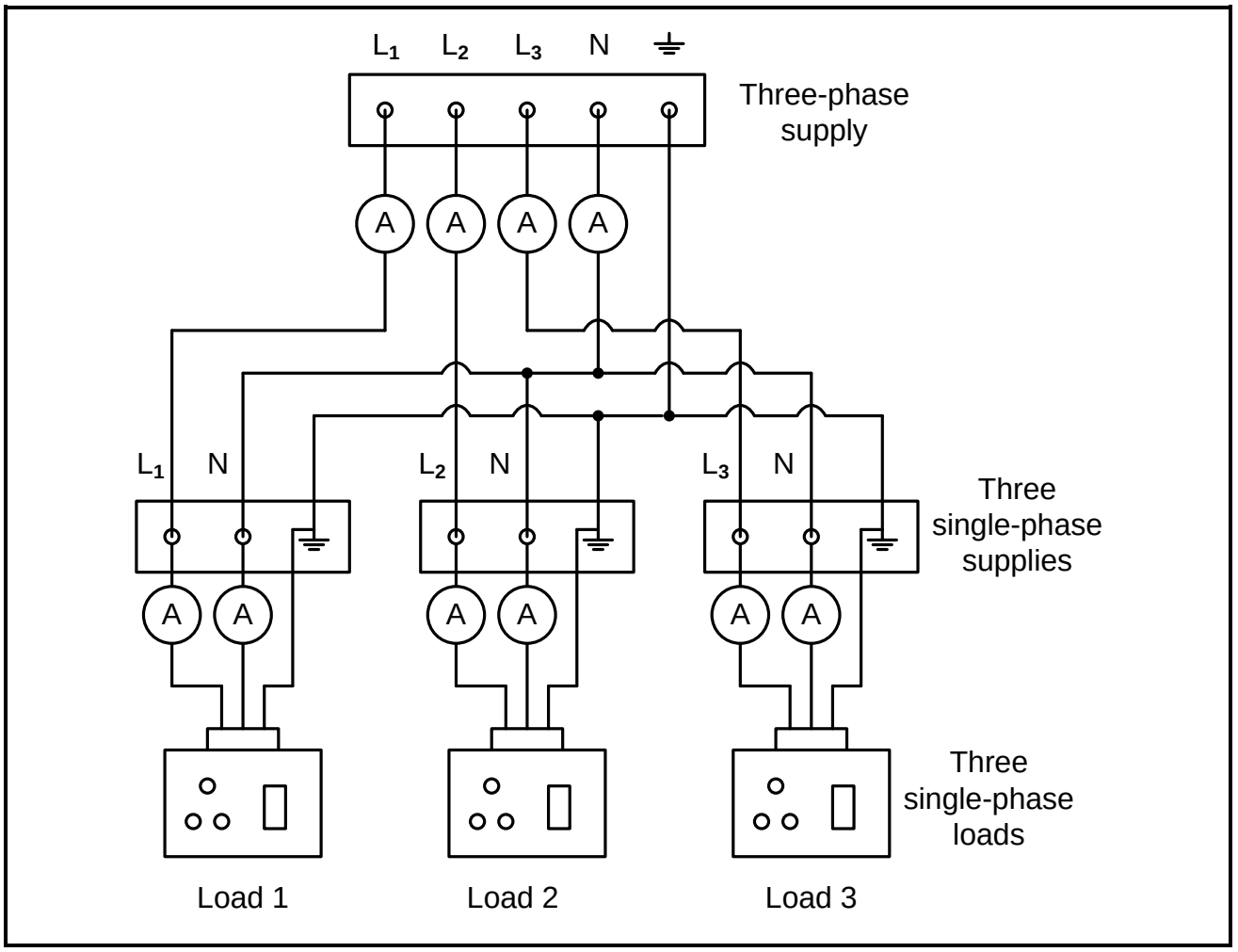


FIGURE 4.2.3

4.2.4 Connect three identical loads to each socket outlet and take the voltage and current measurements as indicated in TABLE 4.2.4 below (e.g. load 1, 2 and 3 = 100 W).

THREE-PHASE SUPPLY	VOLTAGE (LINE)	CURRENT (LINE)	CURRENT (NEUTRAL)
Line 1			
Line 2			
Line 3			
Neutral			
SINGLE-PHASE LOAD	**VOLTAGE (PHASE)**	**CURRENT (LIVE)**	**CURRENT (NEUTRAL)**
LOAD 1			
LOAD 2			
LOAD 3			

TABLE 4.2.4 (16)

4.2.5 Calculate the apparent power of the three-phase supply by using the measurements in TABLE 4.2.4.

_____

_____

_____ (3)

4.2.6 Calculate the apparent power of one of the identical single-phase loads by using the measurements in TABLE 4.2.4.

_____

_____

_____ (3)

4.2.7 Draw a three-phase phasor diagram in the space below by using the line current values measured in each of the lines of the three-phase supply in TABLE 4.2.4.

(4)

4.2.8 Refer to TABLE 4.2.4 and compare the current measurements in the neutral conductors of the single-phase loads to the current in the neutral conductor of the three-phase supply. Motivate why this happens.

_____

_____

_____

_____ (3)

4.2.9 Change load 3 to at least double (or any value up to 1 000 W) the initial value and take the voltage and current measurements as indicated in TABLE 4.2.9 below. Ensure that there is a significant difference between the sizes (wattage) of the loads.
(e.g. load 1 = 100 W, load 2 = 100 W, load 3 = 500 W or any value up to 1 000 W)

THREE-PHASE SUPPLY	VOLTAGE (LINE)	CURRENT (LINE)	CURRENT (NEUTRAL)
Line 1	Already measured in 4.2.4	Already measured in 4.2.4	
Line 2	Already measured in 4.2.4	Already measured in 4.2.4	
Line 3			
Neutral			
SINGLE-PHASE LOAD	**VOLTAGE (PHASE)**	**CURRENT (LIVE)**	**CURRENT (NEUTRAL)**
LOAD 1	Already measured in 4.2.4	Already measured in 4.2.4	Already measured in 4.2.4
LOAD 2	Already measured in 4.2.4	Already measured in 4.2.4	Already measured in 4.2.4
LOAD 3			

TABLE 4.2.9 (6)

4.2.10 Calculate the apparent power of the single-phase load that changed by using the values in TABLE 4.2.9.

_____

_____

_____

_____ (3)

4.2.11 Compare the current in the neutral conductor from the three-phase supply in TABLE 4.2.4 vs the current in the neutral conductor from the three-phase supply in TABLE 4.2.9. Motivate why this happens.

_____

_____

_____

_____ (4)
(42)

NOTE: Learner competency in this context will mean the following:
(This is done for easy assessment when using a rubric.)

Not yet competent	Have not met the requirements and will be given another opportunity for re-assessment. • Be precise about what they did wrong, or the areas they need to improve in. • Clearly explain the level of skill they need to achieve to be assessed as 'competent'. • Indicate whether part or all the assessment events will need to be repeated.
Competent	Have the necessary ability, knowledge, or skill to complete the task successfully. ● Acceptable and satisfactory, though not outstanding.
Outstanding	Went beyond expectation (neatness, proficiency – high degree of skills, expertise)

FACET SHEET FOR SIMULATION 2

Task description	Mark allocation (tick the appropriate level next to the task indicated)				Allocation of marks
	Not yet competent after reassessment of certain/ all parts of the task	**Competent after reassessment of certain parts of the task**	**Competent**	**Outstanding (Highly competent)**	
Current and voltage measurements	The learner was given opportunities to redo part of current and voltage measurements after the teacher intervened in identifying and rectifying mistakes. **(1)**	The learner was given opportunities to redo current and voltage measurements after the teacher intervened in identifying and rectifying mistakes. **(2)**	The learner correctly did current and voltage measurements on the circuit without the guidance of the teacher. **(3)**	The learner correctly did current and voltage measurements on the circuit without the guidance of the teacher and went beyond expectations and with high proficiency. **(4)**	$\overline{4}$
Safety aspects	The learner was timeously reminded to apply safety rules, regulation and correct procedure when using tools and instruments. **(0)**	The learner was sometimes reminded to apply safety rules, regulation and correct procedure when using tools and instruments. **(1)**	The learner applied safety rules, regulation and correct procedure when using tools and instruments to wire the circuits without being reminded by the teacher. **(2)**		$\overline{2}$
Attitude/ Behaviour/ Conduct	The learner was reluctant to work, cooperate, take responsibility of their own conduct and follow instructional, regulation and workshop practice even after being cautioned/reprimanded. **(0)**	The learner was reluctant to a certain degree to work, cooperate, take responsibility of their own conduct and follow instructional, regulation and workshop practice. **(1)**	The learner demonstrated willingness to work, cooperate, take responsibility of their own conduct and follow instructional, regulation and workshop practice. **(2)**		$\overline{2}$
				Rubric	$\overline{8}$
				Simulation Theory and Measurements	**+** $\overline{42}$
				Total Simulation 2	**=** $\overline{50}$

4.3 Simulation 3: Automatic star-delta starter with overload

Name of learner: _____	Mark _____ / **50**
Class: _____ Date completed: _____	
Date Assessed: _____ Assessor Signature: _____	
Date Moderated: _____ Moderator Signature: _____	

4.3.1 Purpose:

- To wire an automatic star-delta motor starter with a timer
- To investigate the start-up current vs the running current
- To do fault finding on the control circuit after the teacher inserted a fault

4.3.2 Required resources:

TOOLS/INSTRUMENTS	MATERIALS
2 x three-phase contactors with auxiliary contacts (for star and delta) 1 x three-phase main contactor 1 x three-phase overload relay 1 x timer relay (pneumatic or electronic) 1 x stop button 1 x start button 1 x three-phase induction motor Correct wire size or plug-in leads Wire stripper Long-nose pliers Screwdriver Side cutters	Multimeter or continuity tester Multimeter or voltmeter Clamp-on ammeter Stopwatch

4.3.3 Procedure A:

- Consider all safety aspects before and during the wiring process and be cautious until the circuit is operating.
- Build the control circuit and let the teacher check it before switching on the supply.
- Build the control circuit to test the operation.
- Set the timer to the required delay time.
- Perform a continuity test to ensure the circuit is connected correctly before powering the circuit
- Request your teacher to check your control circuit before switching on.
- After the control circuit operates correctly, the teacher inserts a fault in the control circuit for the learner to find and solve.
- The teacher checks that the inserted fault is corrected.
- Switch on to test the control circuit.

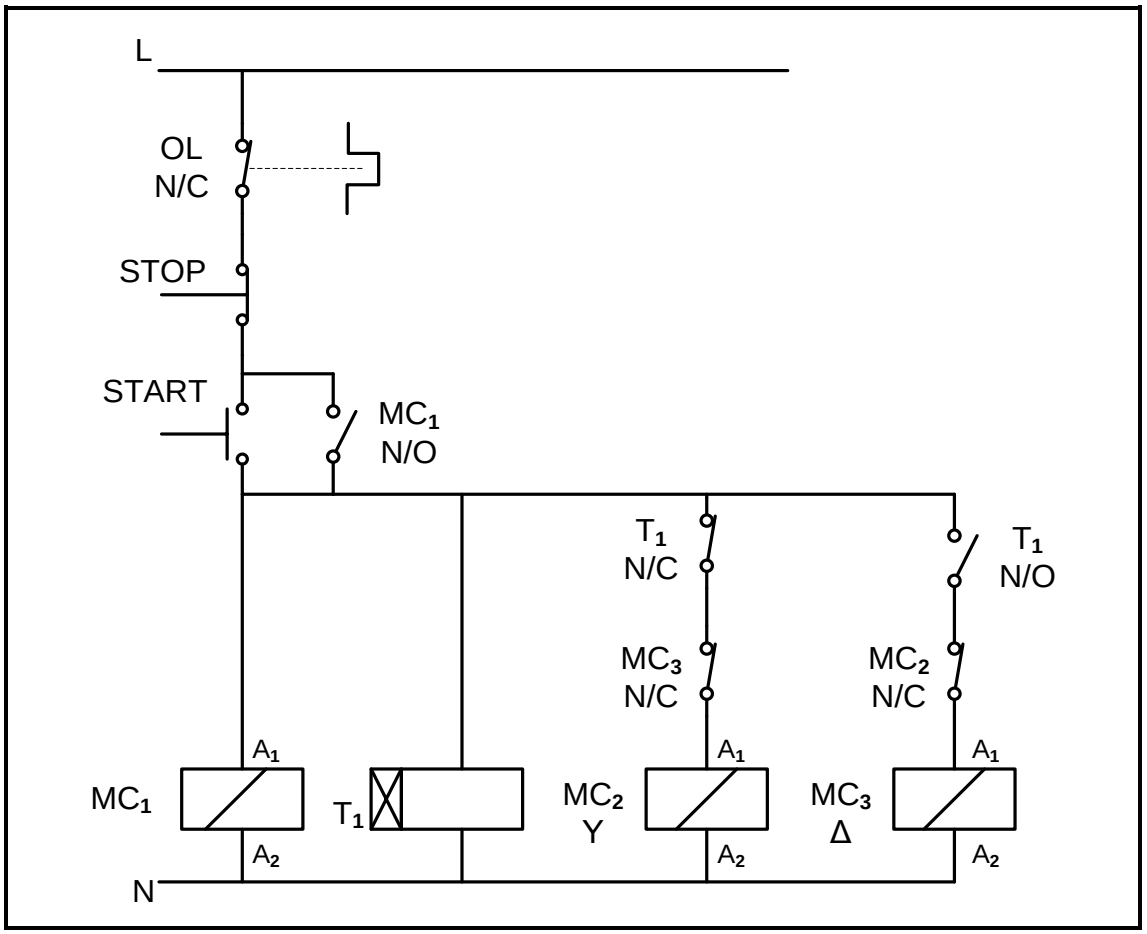


FIGURE 4.3.3: AUTOMATIC STAR-DELTA MOTOR CONTROL CIRCUIT WITH OVERLOAD AND TIMER

Set the time delay to a value between 5–10 seconds.
(Choose a different time-delay for each learner.)

4.3.4 Ask your teacher to check the control circuit before switching the supply on

(a) Press the 'START FWD' button and observe.
Did MC_1 energise? Yes/No _____ (1)

(b) Did MC_2 energise? Yes/No _____ (1)

(c) Did the timer energise? Yes/No _____ (1)

Write down the delay time: _____ (1)

Learner able (✓) not able (X) to adjust the timer. (1)

(d) State what happened to contactors MC_2 and MC_3 after the time delay.

_____

_____

_____ (2)

Press the STOP button.

4.3.5 (a) Write down the TWO contacts responsible for interlocking.

_____
_____ (2)

(b) Explain why it is safe to say that the timer used is an on-delay timer.

_____
_____
_____
_____ (2)

(c) Explain the operation of the control circuit when the start button is pressed. Only refer to the contactors and timer contactor in your answer.

_____
_____
_____
_____
_____
_____
_____ (4)

(15)

4.3.6 **Procedure B:**

Consider all safety aspects before and during the wiring and measuring processes and be cautious until the motor is stopped.

- Build and test the power circuit.
- Ask your teacher to check the power circuit before switching the supply on.
- Start the motor and observe.
- Take the voltage and current measurements as indicated in FIGURE 4.3.6(a) and FIGURE 4.3.6(b).
- Ensure that the phase voltages are all within acceptable range to each other and record the measurement of one of the phases in TABLE 4.3.7 when the motor is running in star and after it switched to delta.
- Ensure that the line currents are all within acceptable range to each other and record the current measurement of the same phase for which the voltage was taken in the previous step in TABLE 4.3.7, when the motor is running in star and after it switched to delta.
- Allow enough time for the voltage and current measurements to settle when recording the voltage and current measurements in star and in delta.
- Press the stop button.
- Repeat until all measurements are accurately recorded.

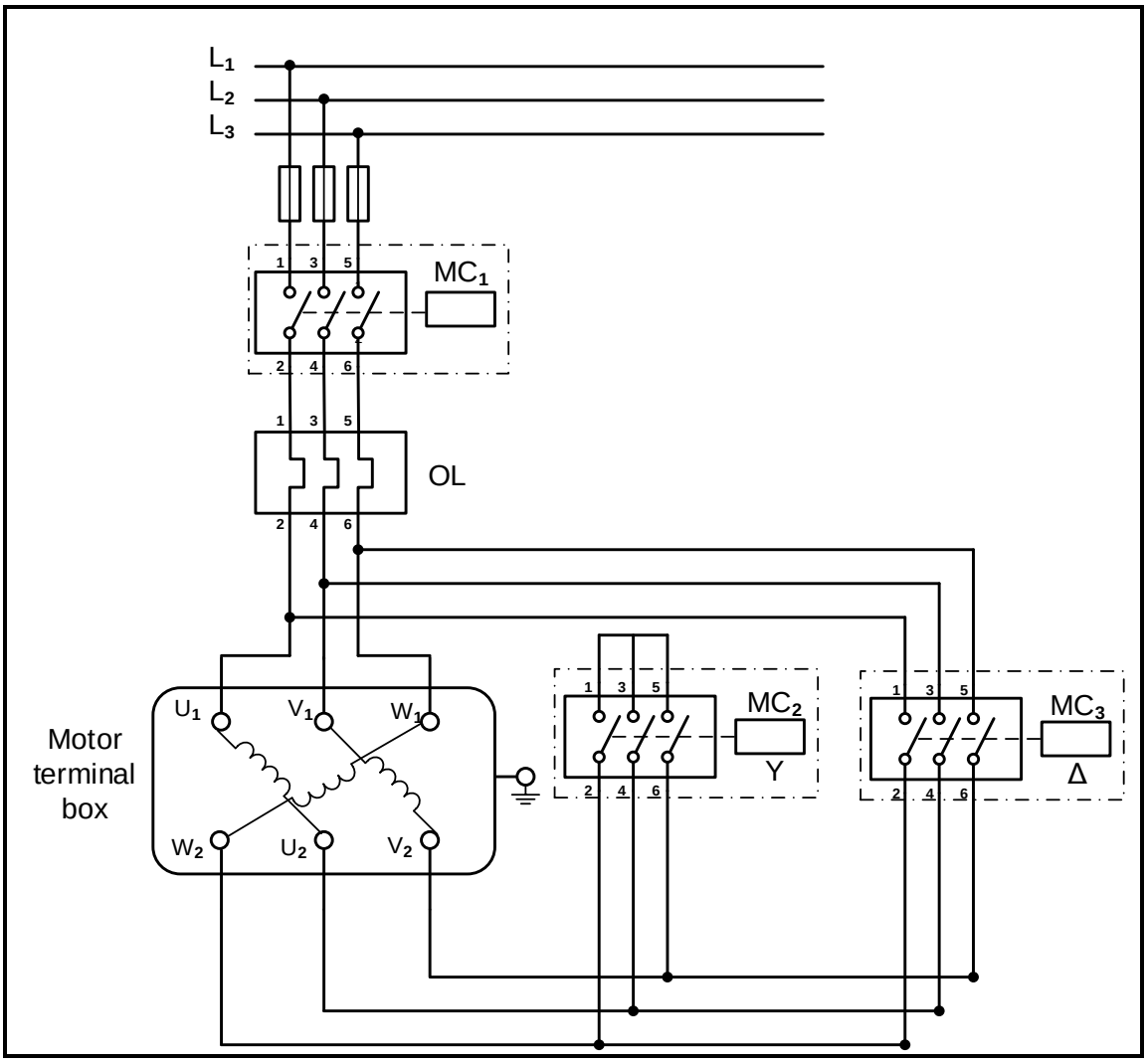


FIGURE 4.3.6: AUTOMATIC STAR-DELTA POWER CIRCUIT DIAGRAM

Refer to FIGURE 4.3.6(a) and FIGURE 4.3.6(b) below when taking the phase voltage and line current measurements.

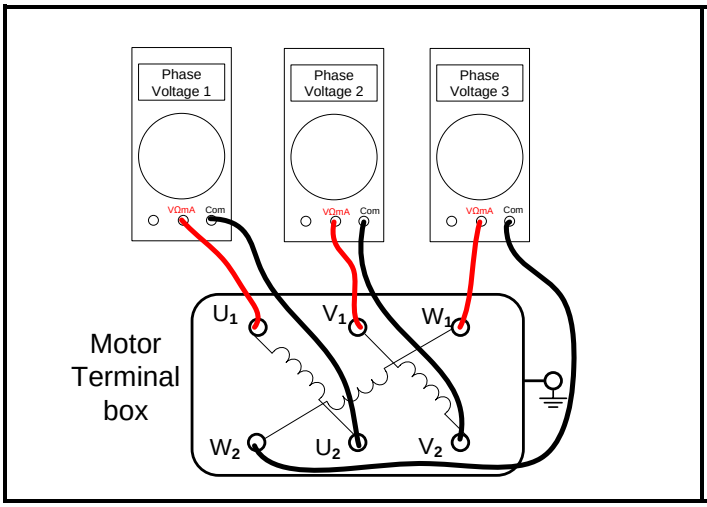


FIGURE 4.3.6(a)

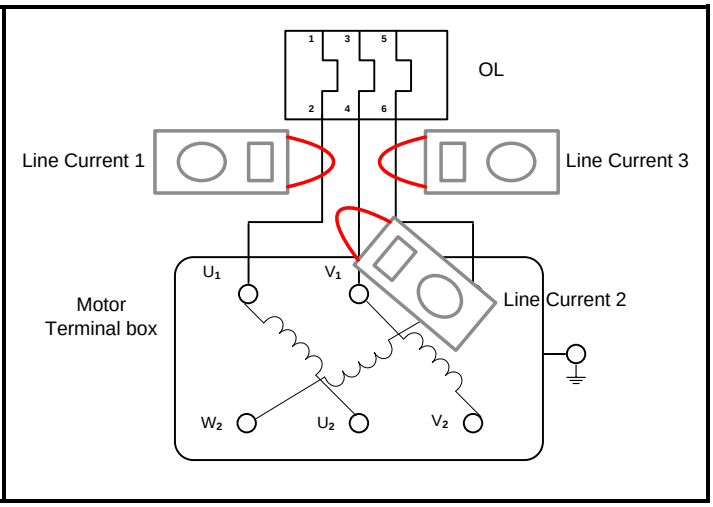


FIGURE 4.3.6(b)

4.3.7 Measure the phase voltage of one of the phases and the corresponding line current as indicated in FIGURE 4.3.6(a) and FIGURE 4.3.6(b) above and record your measurements in TABLE 4.3.7 below. Ensure that the same line and phase are measured for both voltage and current measurements.

	PHASE VOLTAGE
Motor in star	
Motor in delta	
	LINE CURRENT
Motor in star	
Motor in delta	

TABLE 4.3.7 (4)

4.3.8 Compare the phase voltage in star vs delta and explain why this happens.

_____

_____

_____ (2)

4.3.9 Compare the line current in star vs delta and write a conclusion of why this happens. Refer to the power, voltage and current of the motor in your response.

_____

_____

_____

_____

_____ (4)

(10)

FACET SHEET FOR SIMULATION 3

Task description	Mark allocation (tick the appropriate level next to the task indicated)				Allocation of marks
	Not yet competent after reassessment of certain/ all parts of the task	**Competent after reassessment of certain parts of the task**	**Competent**	**Outstanding (Highly competent)**	
Wiring the control circuit on the panel	The learner was given opportunities to rewire the circuit on the panel after the teacher intervened in identifying and rectifying more mistakes. **(1–2)**	The learner was given an opportunity to rewire the control circuit on the panel after the teacher intervened in identifying and rectifying a few mistakes. **(3–4)**	The learner correctly wired the control circuit on the panel without guidance of the teacher. **(5–6)**	The learner correctly wired the control circuit on the panel without guidance of the teacher and went beyond expectations and with high proficiency. **(7–8)**	$\overline{8}$
Wiring the power circuit on the panel	The learner was given opportunities to rewire the circuit on the panel after the teacher intervened in identifying and rectifying more mistakes. **(1–2)**	The learner was given an opportunity to rewire the power circuit on the panel after the teacher intervened in identifying and rectifying few mistakes. **(3–4)**	The learner correctly wired the power circuit on the panel without guidance of the teacher. **(5–6)**	The learner correctly wired the powe circuit on the panel without guidance of the teacher and went beyond expectations and with high proficiency. **(7–8)**	$\overline{8}$
Fault finding	The learners were given opportunities to re-identify and correct the fault after more interventions of the teacher. **(1–2)**	The learners were given an opportunity to re-identify and correct the fault after a few interventions of the teacher. **(3–4)**	The learners were able to identify/find the fault inserted by the teacher and corrected it. **(5)**		$\overline{5}$
Safety aspects	The learner was timeously reminded to apply safety rules, regulation and correct procedure when using tools and instruments. **(0)**	The learner was sometimes reminded to apply safety rules, regulation and correct procedure when using tools and instruments. **(1)**	The learner applied safety rules, regulation and correct procedure when using tools and instruments to wire the circuits without being reminded by the teacher. **(2)**		$\overline{2}$
Attitude/ Behaviour/ Conduct	The learner was reluctant to work, cooperate, take responsibility of their own conduct and follow instructional, regulation and workshop practice even after being cautioned/reprimanded. **(0)**	The learner was reluctant to a certain degree to work, cooperate, take responsibility of their own conduct and follow instructional, regulation and workshop practice. **(1)**	The learner demonstrated willingness to work, cooperate, take responsibility of their own conduct and follow instructional, regulation and workshop practice. **(2)**		$\overline{2}$
				Rubric	$\overline{\mathbf{25}}$
				Simulation 3	$+\ \overline{\mathbf{25}}$
				Total	$=\ \overline{\mathbf{50}}$

4.4 Simulation 4: Three-phase forward-reverse motor starter with overload and pilot lights using PLC

Name of learner: _____	
Class: _____ Date completed: _____	Mark _____ **50**
Date Assessed: _____ Assessor Signature: _____	
Date Moderated: _____ Moderator Signature: _____	

4.4.1 Purpose:

- To convert a forward reverse motor starter control circuit with overload and indication lights to a ladder logic diagram
- To operate a three-phase induction motor through the PLC after programming and loading the program to the PLC

4.4.2 Required resources:

TOOLS/INSTRUMENTS	MATERIALS
Multimeter/Clamp meter or continuity tester Computer/Programmer Programming cable Wire stripper Long-nose pliers Screwdriver Side cutters	Connecting wires PLC unit with 4 outputs 1 x three-phase induction motor (star or delta) 1 x three-phase overload relay 1 x stop button 2 x start buttons 2 x three-phase contactors 1 x green pilot light (230 V) 1 x yellow pilot light (230 V)

4.4.3 Procedure:

- Convert the (relay logic circuit) control circuit in FIGURE 4.4.4(a) into a ladder logic diagram.
- Program the ladder logic diagram through a computer.
- Set the time delay to 3 seconds.
- Run the PLC program in the computer and simulate the operation.
- Load the program from a computer to a PLC.
- Ensure the PLC is in run mode.
- Disconnect the programming cable.
- Switch off the supply.
- Connect the PLC to the control of the circuit.
- Only switch ON the supply after your teacher has checked the circuit and confirmed it as correct.
- If the program and control circuit are working, switch OFF the power supply.
- Wire the power circuit to the motor.
- Ask your teacher to check the wiring of the power circuit before switching it ON.
- The teacher will insert faults on the PLC and the learner must identify and correct them.
- Ask your teacher to inspect the circuit and ensure that all faults are corrected.

4.4.4 **Control circuit**

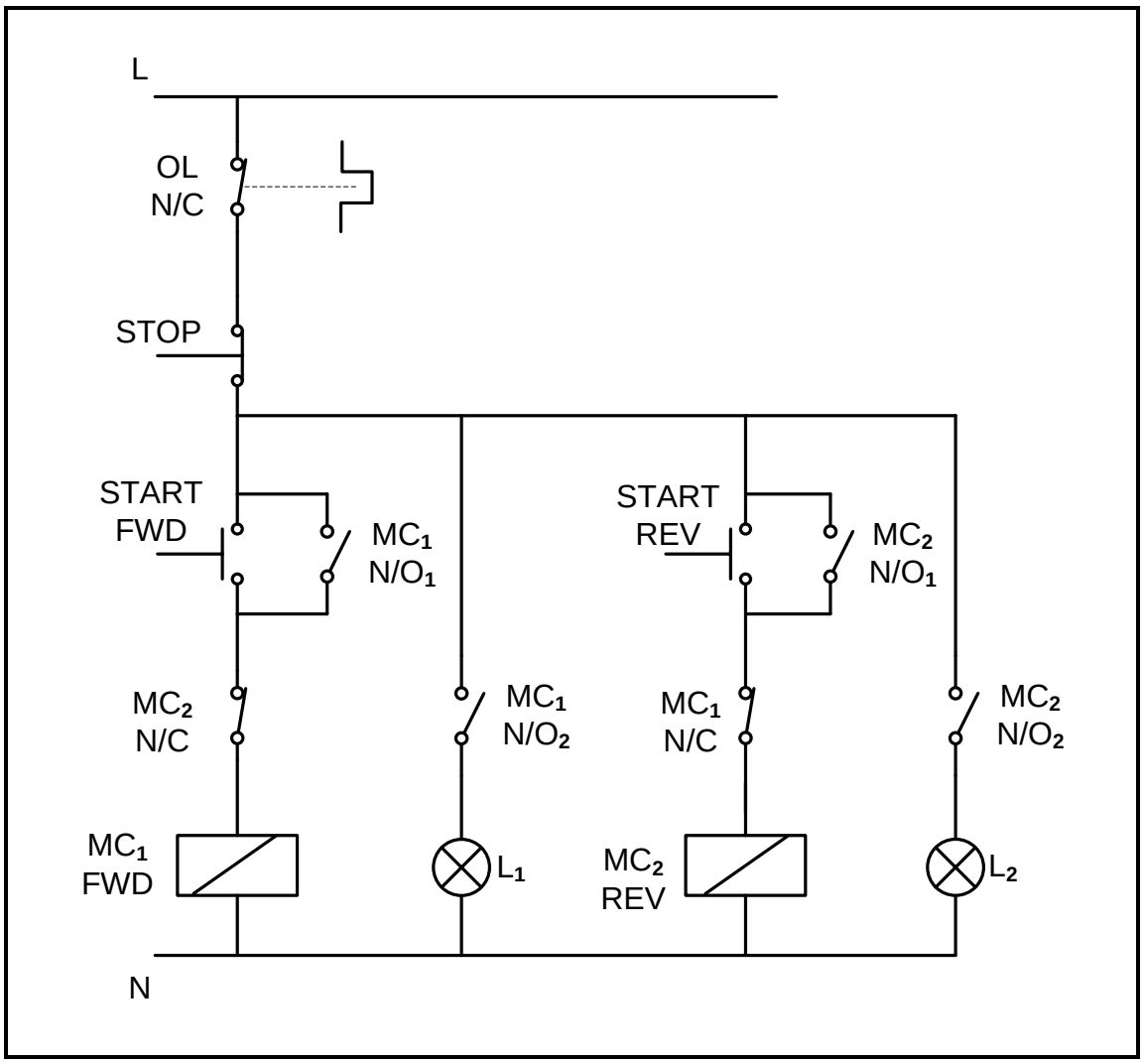


FIGURE 4.4.4(a): CONTROL CIRCUIT

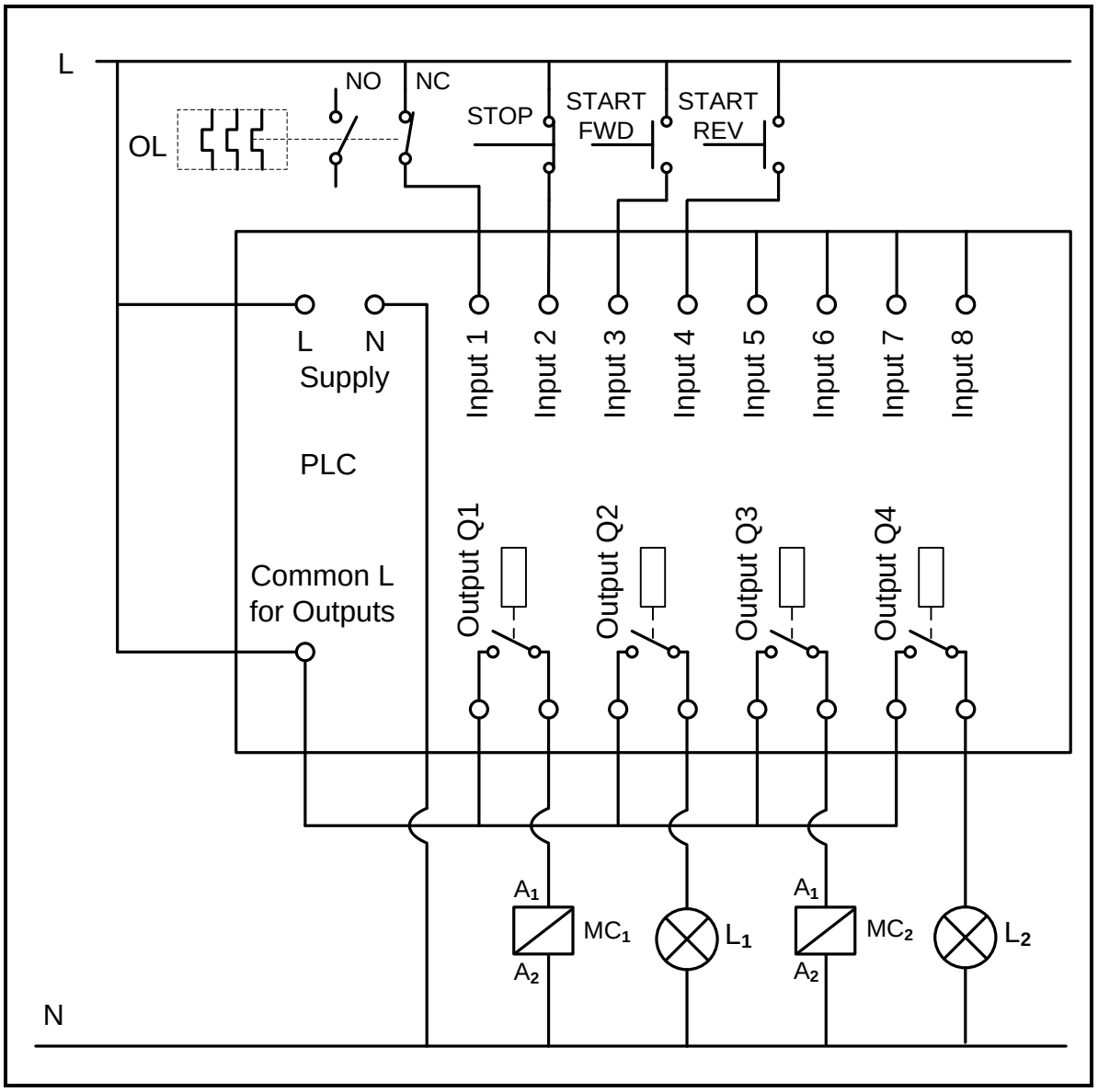


FIGURE 4.4.4(b): PLC UNIT CONNECTED TO THE CONTROL CIRCUIT

Inputs:

$X_1/I0_1$ = OL N/C
$X_2/I0_2$ = Stop button
$X_3/I0_3$ = Start button FWD
$X_4/I0_4$ = Start button REV

Outputs:

$Q_1 = MC_1$
$Q_2 = L_1$ (Green)
$Q_3 = MC_2$
$Q_4 = L_2$ (Yellow)

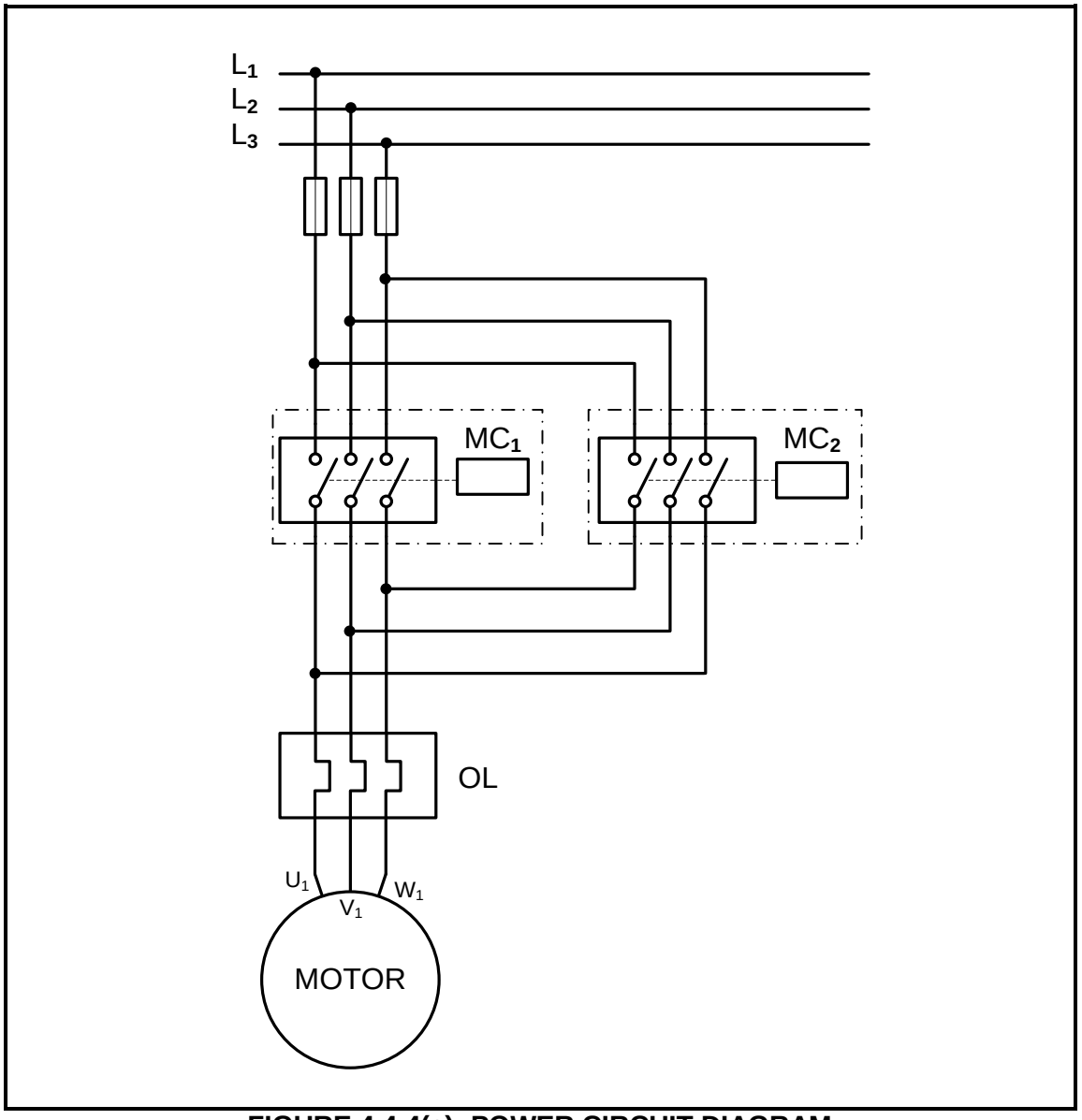


FIGURE 4.4.4(c): POWER CIRCUIT DIAGRAM

4.4.5 Take a snapshot (screenshot) of the programmed ladder logic diagram. Save, print and paste it on the blank space below. Ensure that your name and the circuit name appear on the title block of the circuit.

(12)

4.4.6 Name FOUR components/functions in the control circuit that are only soft-wired and not hard-wired in the PLC system.

(4)

4.4.7 Explain how interlocking takes place within the PLC program.

(4)
(20)

FACET SHEET FOR SIMULATION 4

Task description	Mark allocation (tick the appropriate level next to the task indicated)				Allocation of marks
	Not yet competent after reassessment of certain/ all parts of the task	**Competent after reassessment of certain parts of the task**	**Competent**	**Outstanding (Highly competent)**	
Loading the program to the PLC	The learner was given opportunities to reload the program after the teacher intervened in identifying and rectifying several mistakes. **(1)**	The learner was given an opportunity to reload the program after the teacher intervened in identifying and rectifying few mistakes. **(2–3)**	The learner correctly loaded the program to the PLC without the guidance of the teacher. **(4–5)**	The learner correctly loaded the program to the PLC without the guidance of the teacher and went beyond expectations and with high proficiency. **(6)**	$\overline{6}$
Wiring the control circuit to the PLC	The learner was given opportunities to rewire the circuit on the panel after the teacher intervened in identifying and rectifying more mistakes. **(1–2)**	The learner was given an opportunity to rewire the control circuit on the panel after the teacher intervened in identifying and rectifying a few mistakes. **(3–4)**	The learner correctly wired the control circuit on the panel without the guidance of the teacher. **(5–6)**	The learner correctly wired the control circuit on the panel without the guidance of the teacher and went beyond expectations and with high proficiency. **(7–8)**	$\overline{8}$
Wiring the power circuit on the panel	The learner was given opportunities to rewire the circuit on the panel after the teacher intervened in identifying and rectifying more mistakes. **(1–2)**	The learner was given an opportunity to rewire the power circuit on the panel after the teacher intervened in identifying and rectifying a few mistakes. **(3–4)**	The learner correctly wired the power circuit on the panel without the guidance of the teacher. **(5–6)**	The learner correctly wired the power circuit on the panel without the guidance of the teacher and went beyond expectations and with high proficiency. **(7)**	$\overline{7}$
Fault finding	The learner was given opportunities to re-identify and correct the fault after more interventions of the teacher. **(1–2)**	The learner was given an opportunity to re-identify and correct the fault after few interventions of the teacher. **(3–4)**	The learner was able to identify/find the fault inserted by the teacher and corrected it. **(5)**		$\overline{5}$
Safety aspects	The learner was timeously reminded to apply safety rules, regulation and correct procedure when using tools and instruments. **(0**	The learner was sometimes reminded to apply safety rules, regulation and correct procedure when using tools and instruments. **(1)**	The learner applied safety rules, regulation and correct procedure when using tools and instruments to wire the circuits without being reminded by the teacher. **(2)**		$\overline{2}$
Attitude/ Behaviour/ Conduct	The learner was reluctant to work, cooperate, take responsibility of their own conduct and follow instructional, regulation and work-shop practice even after being cautioned/ reprimanded. **(0)**	The learner was reluctant to a certain degree to work, cooperate, take responsibility of their own conduct and follow instructional, regulation and workshop practice. **(1)**	The learner demonstrated willingness to work, cooperate, take responsibility of their own conduct and follow instructional, regulation and workshop practice. **(2)**		$\overline{2}$
				Rubric	$\overline{\mathbf{30}}$
				Simulation 4	$+\ \overline{\mathbf{20}}$
				Total	$=\ \overline{\mathbf{50}}$

5. SECTION B: DESIGN AND MAKE

Design and Make Project

Time: January to August 2025

Learner Name: _____

School: _____

Class: _____

Title/Type of Project: _____

INSTRUCTIONS

- This section is COMPULSORY for all learners.
- The teacher will choose a circuit for the project.
- Any project constructed must include at least (but is not limited to):
  - Seven components
  - A variety of components (both active and passive)
  - PCB making in some form
  - Soldering
  - An enclosure with a switch and protection
- The checklist below must be used to ensure that all the required tasks for the PAT have been completed.

PAT CHECKLIST

The learner MUST fill in this checklist BEFORE marking of the section takes place.

NO.	DESCRIPTION	TICK (☑)	
		NO	YES
Design and Make: Part 1			
1.	Circuit diagram drawn	☐	☐
2.	Circuit description filled in	☐	☐
3.	Component list completed	☐	☐
4.	Tools list for circuitry populated	☐	☐
5.	Measuring instrument list filled in	☐	☐
Design and Make: Part 2			
1.	Enclosure design completed and included in the file	☐	☐
2.	Unique name written down and on the enclosure	☐	☐
3.	Logo designed and on the enclosure	☐	☐
Miscellaneous			
1.	Enclosure included in the project	☐	☐
2.	Enclosure prepared and drilled according to the design	☐	☐
3.	Enclosure finished off and completed with name and logo	☐	☐
4.	PCB securely mounted in the enclosure using acceptable techniques	☐	☐
5.	Circuit inside the enclosure accessible	☐	☐
6.	Internal wiring neat and ready for inspection	☐	☐
7.	File and project completed and ready for moderation at the workshop/room	☐	☐

5.1 Design and Make: Part 1

5.1.1 Circuit diagram

Draw a circuit diagram of the project chosen and paste it on the next page.

5.1.2 Project: Description of operation

Use the space below to describe how the project operates. Do research and use your own words.

5.1.3 **Component list**

List the components you will need for the circuit diagram.

LABEL	DESCRIPTION AND VALUE	QUANTITY

5.1.4 **Tools/Instrument list**

List the tools needed to complete the project.

DESCRIPTION	PURPOSE

5.2 Assessment of the Design and Make Phase: Part 1

NO.	FACET DESCRIPTION	Mark	Achieved mark
Circuit Diagram			
1.	The circuit diagram was drawn using • EGD equipment (4) • CAD/Any electronic design software (6)	6	
2.	The circuit diagram was drawn using correct symbols.	3	
3.	The circuit diagram has all labels, e.g. R1, C1, Tr1	3	
4.	The circuit diagram has all component values, e.g. 100 Ω, 220 µF	4	
5.	The circuit diagram has a name/title.	2	
6.	The circuit diagram has a frame and title block.	2	
	Circuit Diagram Subtotal:	**20**	
Component List			
7.	Labels correlate with circuit diagram.	2	
8.	Description and values correlate with circuit diagram.	2	
9.	Quantities are correct.	1	
	Component List Subtotal:	**5**	
Description of Operation			
10.	Basic function of the circuit is described correctly. The purpose/role/function of each component is described.	11	
11.	All subcircuits in the circuit diagram and component list are included in the description.	4	
12.	Purposes of subcircuits in the circuit diagram are described correctly.	5	
13.	Learner used own interpretation and did not copy from another source verbatim.	3	
14.	Sources are acknowledged.	2	
	Description of Operation Subtotal:	**25**	
Tools/Instrument List			
15.	The tools/instrument list has been completed.	4	
16.	The tools/instruments listed all have a purpose for being used.	1	
	Tools/Instrument List Subtotal:	**5**	

NO.	FACET DESCRIPTION	Mark	Achieved mark
Circuit Board Manufacturing			
17.	Transfer of the PCB design onto the blank board is correct. Not over-exposed or under-exposed.	5	
18.	Circuit board is etched neatly according to the PCB design.	10	
19.	The learner's name is etched onto the circuit design.	4	
20.	All burrs are removed.	2	
21.	Axial and radial components are placed neatly and flush with the board.	5	
22.	Component orientations are aligned between similar components (e.g. the gold band of all resistors are placed on the same side).	2	
23.	Soldered components – leads are cut off, flush and neat on the solder side.	5	
24.	More than 60% of the solder joints are shiny (not dry joints).	5	
25.	Wire insulation is stripped to the correct length (no extra copper showing).	3	
26.	Wiring is long enough to allow for dismantling and inspection.	2	
27.	Wiring is wrapped neatly.	2	
28.	A power switch is included and fitted to the enclosure.	2	
29.	A fuse/protection is included and fitted correctly where applicable.	2	
30.	Wiring entering/exiting the enclosure is provided with a grommet/applicable fittings/socket where applicable.	2	
31.	Batteries/Transformer is mounted using a battery housing/ mounting bracket and battery clip (NO double-sided tape).	2	
32.	The project has a pilot light/LED installed in the enclosure showing when the circuit is operational. LED is mounted with a grommet or applicable fitting. (Switch is on – must go out when fuse is blown.)	2	
33.	The project is fully operational and commissioned/installed in the enclosure.	10	
	Circuit Board Manufacturing Subtotal:	**65**	
	Circuit Diagram Subtotal:	**20**	
	Component List Subtotal:	**5**	
	Description of Operation Subtotal:	**25**	
	Tools/Instrument List Subtotal:	**5**	
	Circuit Board Manufacturing Subtotal:	**65**	

TOTAL (PART 1 = 120 marks)	

NOTE: If pre-etched and pre-manufactured PCBs are used, learners will not be able to receive any marks for facets 17–20.
In projects where facets are not applicable, e.g. projects without transformers/batteries, the projects should be marked, and the totals adjusted accordingly.

5.3 Design and Make: Part 2

5.3.1 Enclosure design

- Design an enclosure for your project.
- NO FREEHAND DRAWINGS.
- Draw using EGD equipment **OR** use a CAD program.
- Draw in first-angle orthographic projection.
- Add your drawings after this page.
- Use colour to enhance your drawing.

5.3.2 Manufacture the enclosure neatly according to your design.

You may use pre-cut panels from metal, wood and/or Perspex/Plexiglas.
You must, however, construct/assemble these parts.
Injection moulded enclosures are also acceptable. It is important that your enclosure and the placement of the parts align with your design.

5.3.3 Choose a name for your device.

Write down the name of the device below.

_____

5.3.4 Design a unique logo for your device, as well as a specification plate and attach it after this page.

Logo design	Specification plate design

5.4 Assessment of the Design and Make Phase: Part 2

NO.	FACET DESCRIPTION	Mark	Achieved mark
Enclosure Design			
1.	Enclosure design is included in first-angle orthographic projection.	2	
2.	Drawn design includes a title box and page border.	1	
3.	Isometric drawing included additionally.	2	
4.	Dimensions are included.	2	
5.	The name of the device is written in the PAT document.	1	
6.	The logo design and specification plate design is in the PAT document.	2	
	Enclosure Design Subtotal:	**10**	
Enclosure Manufacturing			
7.	Enclosure matches the design. Dimensions and placement correlate.	1	
8.	Name of the device is attached on the enclosure.	1	
9.	The logo design is attached on the enclosure.	2	
10.	The logo design on the enclosure is durable and not merely a paper pasted on the enclosure (painted/used decoupage/screen printed/sublimation printed).	2	
11.	The enclosure is manufactured from scratch/pre-cut parts. Does NOT include: cardboard, paper, margarine container Does include: sheet metal, Perspex, Plexiglas, wood, glass and other raw materials, injection-moulded plastic boxes	5	
12.	Holes/Cut-outs in the enclosure are made with the appropriate tools.	3	
13.	Specification plate with the learner's name, operating voltage, fuse rating and additional information on the project.	2	
14.	Enclosure is neatly prepared, painted and aesthetically pleasing.	2	
15.	The circuit board is mounted using appropriate methods inside the enclosure. (NO double-sided tape, Prestik, glue, chewing gum, masking tape, etc.)	2	
	Enclosure Manufacturing Subtotal:	**20**	

TOTAL (PART 2 = 30 marks)	

6. PROJECTS

6.1 Practical Project: Dual Voltage Power Supply Circuit

This project uses a centre tapped transformer. The recommended rating of the transformer is 240 V to 18-0-18 V transformer.
NOTE: Sometimes the transformer you purchase outputs more than the specified value, so be careful while choosing the transformer.

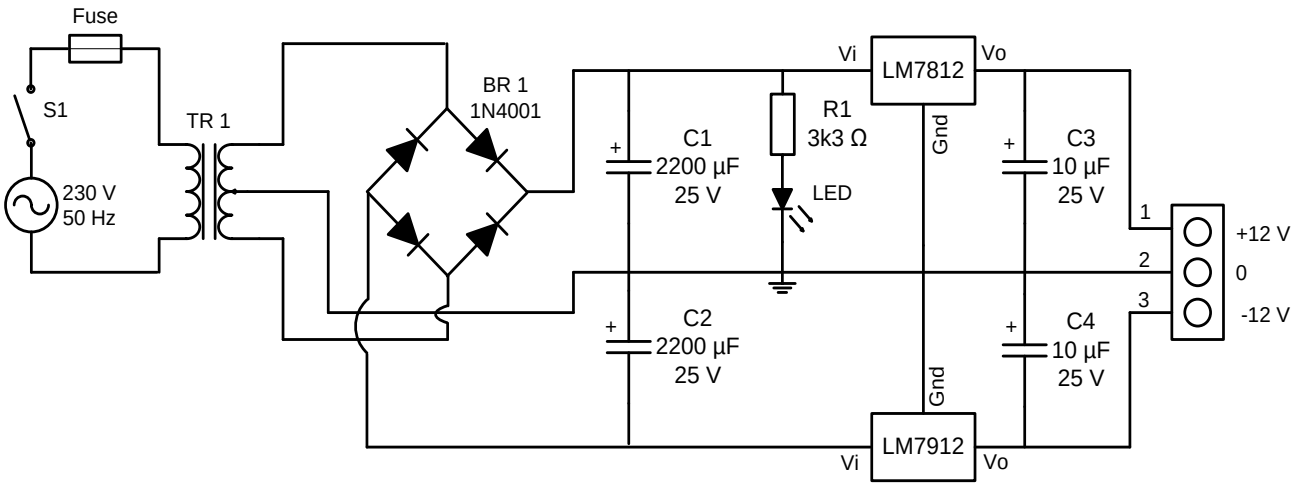
Capacitors C1 and C2 act as smoothing capacitors; this is to even out any fluctuation in voltage. You can also add a bypass capacitor after the C1 and C2 to remove any AC noise which is not showed in the circuit. Next, the two voltage regulators: the 7812 gives positive 12 V and the 7912 gives negative 12 V. Other variants of voltage regulator ICs can also be used.
NOTE: 78xx gives the positive output and 79xx gives the negative output

The capacitors C3 and C4 are used as the bypass capacitor to remove the AC noise and give a pure and cleaner DC signal.

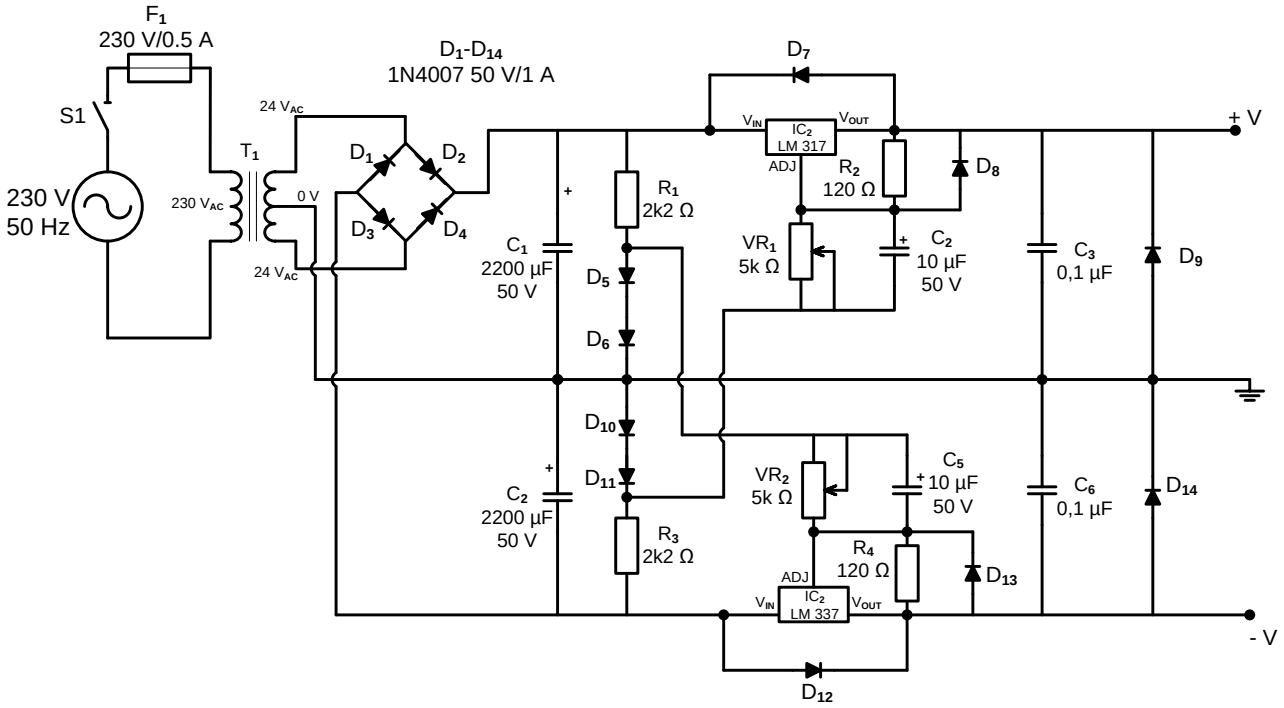
Resources required:

TOOL	MATERIALS	
Multimeter Side cutters Wire strippers Soldering iron Helping Hands PCB etching tank or similar Solder sucker	1 x transformer 240 to 15-0-15 volt - 4 x 1N4001 2 x 2200uF/25V 2 x 10uF/25V 1 x 3,3 kΩ 1 x red LED 2 x heat sink 1 x 3 pin terminal block 1 x grommet – power indicator 1 x grommet/PVC compression gland/solder butt sleeve 3–2 mm – power chord 1 x Cabtyre – ½ meter length	1 x 7812 voltage regulator IC 1 x 7912 voltage regulator IC 1x toggle switch 1 x in line 2 A fuse and holder 1 m mains supply cable 1 x 3 pin plug 1 x PCB 2 x digital panel voltmeter displays

Circuit diagram:



Alternative project: 0-30 V Variable Dual Voltage Power Supply



https://www.eleccircuit.com/0-60-volt-dc-variable-power-supply-using-lm317lm337/

Working explanation

The LM317T is an adjustable regulator IC that can adjust the output voltage from 1,25 V to 37 V. It can provide up to 1,5 A with an input voltage of 3 V to 40 V. Internally, the LM317 has full protection, e.g. short-circuit protection, input over voltage protection, overload protection. Another interesting feature is the elimination of the ripple.

The output voltage (Vo) is determined from the formula Vo =1,25{1+(R2/R1)} where R1 is the resistance constant from 120 ohms to 240 ohms. We can adjust resistor R2 from a minimum value (0 ohms) to any value we want. If R2 is 0 ohms minimum output, the voltage is about 1,25 V. Related: LM317 calculator, making LM317 start at 0 volts.

Electronic circuits require a constant voltage. The output voltage of LM317T may not need to reduce to 0 V. However, in the experiments, it may be necessary to start the voltage at 0 V. Unfortunately, the minimum output voltage is 1,25 V.

The negative voltage regulated IC LM337T is similar to LM317. If the Adj connects to ground, the lowest output voltage is -1,25V.

Diodes D1-D4 are rectifier ACV from 240 volts of the transformer into DCV of about 33 V, in both positive and negative voltage.

The capacitors C1 and C4 are a voltage filter from the bridge diodes to smooth the pulsating DCV.

The R1, D5 and D6 create the reference voltage of +1,25 volts to the LM337T to adjust the voltage to start at 0 V.

The R3, D10 and D11 make voltage -1,25 V to LM317T. It can also adjust the beginning voltage to 0 V.

The D7, D8, and D12 - D13 protects it against backward voltage from the output, which may cause damage to the IC. C2 and C5 are connected to reduce the noise signal from adjusting the potentiometer (VR1, VR2) and smooths the voltage at the output.

After examining and successfully assembling the device, apply AC power.

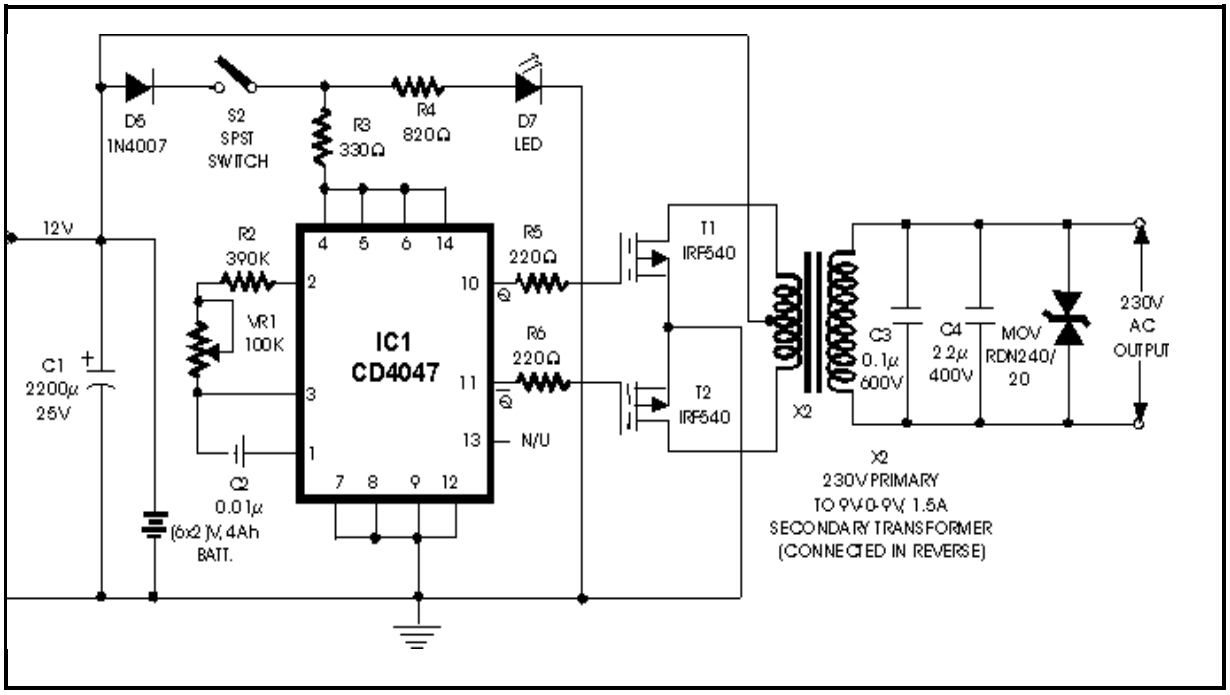
Hold the DC voltmeter to measure the positive output. Then rotate VR1; you can read the voltage from 0–30 volt.

If everything is correct, then move the lead of the meter to measure the negative. Next, adjust the VR2; you can read voltage from 0-30 volts. Alternatively, connect a digital panel voltmeter between ground and +V to display the positive output voltage and a digital panel voltmeter between ground and -V to display the negative output voltage.

6.2 Practical Project: Inverter 100 W 12 VDC to 230 VAC by IC 4047– IRF54

100 W inverter circuit 12 VDC to 230 VAC with IRF540. The circuit applied IC 4047 to generate continuous wave signal and IRF540 to amplify the signal to be stepped up by the transformer.

NOTE: You will need a 2–3 A centre-tapped transformer to handle/supply 100 W load.



INVERTER 100 W 12 VDC TO 230 VAC BY IC 4047 – IRF540

https://electronics-diy.com/12v-dc-to-220v-100w-inverter-4047-irf540.php: 25/09/2024

Component list

Diode	1N4007	VR1	100 KΩ
C1	2 200 µF	R2	390 KΩ
C2	0,01 µF	R3	330 Ω
C 3	0,1 µF	R4	820 Ω
C 4	2,2 µF	R5	220 Ω–330 Ω
Varistor	MOV RDN240/20	R6	220 Ω–330 Ω
IC 4047 – IRF540		2 x D MOSFET (T1) IRF540	
LED		S2 SPST switch	
Supply 12 V or 12 V DC supply for testing			
TRANSFORMER on circuit diagram optional; a smaller one can be used for testing			

NOTE: All circuits MUST include an ON/OFF switch with an ON indicator and fuse protection.

7. CONCLUSION

On completion of the practical assessment task, learners should be able to demonstrate their understanding of the industry, enhance their knowledge, skills, values and reasoning abilities as well as establish connections to life outside the classroom and address real-world challenges. The PAT furthermore develops learners' life skills and provides opportunities for learners to engage in their own learning.