basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

ELECTRICAL TECHNOLOGY (ELECTRONICS)

GUIDELINES FOR PRACTICAL ASSESSMENT TASKS

GRADE 12

2026

These guidelines consist of 48 pages.

Copyright reserved

TABLE OF CONTENTS

		PAGE
1.	**INTRODUCTION**	**3**
2.	**TEACHER GUIDELINES**	**5**
2.1	How to administer PATs	5
2.2	How to mark/assess PATs	5
2.3	PAT Programme of Assessment (PAT PoA)	6
2.4	Moderation of PATs	8
2.5	Absence/Non-submission of tasks	8
2.6	Simulations	9
2.7	Projects	9
2.8	Working mark sheet	10
3.	**LEARNER GUIDELINES**	**11**
3.1	PAT 2026 cover page	11
3.2	Instructions to the learner	12
3.3	Declaration of Authenticity (COMPULSORY)	12
4.	**SIMULATIONS**	**13**
4.1	Simulation 1: RLC series circuit	13
4.2	Simulation 2A: MOSFET used as a switch	19
	Simulation 2B: MOSFET used as an amplifier	23
4.3	Simulation 3: Switching circuits using 555 IC	26
4.4	Simulation 4: Two-stage RC-coupled amplifier	32
5.	**SECTION B: DESIGN AND MAKE**	**38**
5.1	Design and Make: Part 1	39
5.2	Assessment of the Design and Make Phase: Part 1	41
5.3	Design and Make: Part 2	43
5.4	Assessment of the Design and Make Phase: Part 2	44
6.	**PROJECTS**	**45**
6.1	Practical Project: Dual voltage power supply	45
6.2	Practical Project: TDA2030 Audio Amplifier with bass, treble and tone control	47
7.	**CONCLUSION**	**48**

Copyright reserved

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
- SERVICES: Consumer Studies, Hospitality Studies, Tourism
- TECHNOLOGY: Civil Technology, Electrical Technology, Mechanical Technology and Engineering Graphics and Design
- TECHNICAL: Technical Sciences; Technical Mathematics

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 TWO simulations available for ELECTRONICS. 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.

Copyright reserved

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 2026 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 2026**, in time for moderation.

Copyright reserved

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 a **and must be completed and internally moderated before 31 August 2026. The PAT should be ready for external moderation at the start of PAT moderation programs on 1 September 2026.** 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.

Copyright reserved

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 2026	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 2026	Simulation 1	Teacher – Copies and hands out simulations Learners – Complete simulations Teacher – Assesses simulations DH – Checks if tasks have been completed and marked by the teacher before the holidays
January 2026	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 DH – Checks in on teacher to see if the process is adhered to
February- March 2026	PAT project – learners commence with project	Teacher – Ensures that there is secure storage for PAT projects Teacher – Hands out PAT projects and collects 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 DH – Checks in on teacher to ensure that practical workshop sessions take place on a weekly basis
April–June 2026	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 DH – Checks if tasks have been completed and marked by the teacher before the holidays
April–June 2026	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 2026	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 DH – Checks in on teacher to ensure that practical workshop sessions take place on a weekly basis
July holidays 2026	PAT intervention	Learners that are behind on the PAT are required to complete the project during these holidays
July–August 2026	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

Copyright reserved

TIME FRAME	ACTIVITY	RESPONSIBILITY
July–August 2026	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 DH – Checks to see that 100% of the PAT files and projects are completed and assessed
September 2026	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 2026	PAT moderation	PAT projects and simulations are moderated by subject specialists from DBE and learners are available to demonstrate skills 10% of learners are moderated randomly

Copyright reserved

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.

Copyright reserved

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 **between Simulation 1 and 2 for term 1 and between Simulation 3 and 4 for term 2 from the** 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.

Copyright reserved

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 out of 100
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:_____

Copyright reserved

3. LEARNER GUIDELINES

3.1 PAT 2026 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 (2026)

Learner Name: _____

Class: _____

School: _____

Specialisation: ELECTRONICS

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 Simulation 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 connect/build an RLC series circuit
- To compare the voltage drops across the components with a change in frequency in an RLC series circuit
- To draw a phasor diagram from the signals displayed on the oscilloscope

4.1.2 **Required resources:**

TOOLS/INSTRUMENTS	MATERIALS
Function generator Experiment board Connecting wires 1 x multimeter Oscilloscope (dual channel)	2,2 mH inductor (2 mH) 2,2 µF capacitor (non-polarised) 1 kΩ resistor (brown, black, red 5% - ½ Watt)

4.1.3 **Procedure:**

- Connect/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 VPK. (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, 2,3 kHz and 50 kHz.
- Take the voltage measurements, using the oscilloscope settings and record your findings.
- 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.

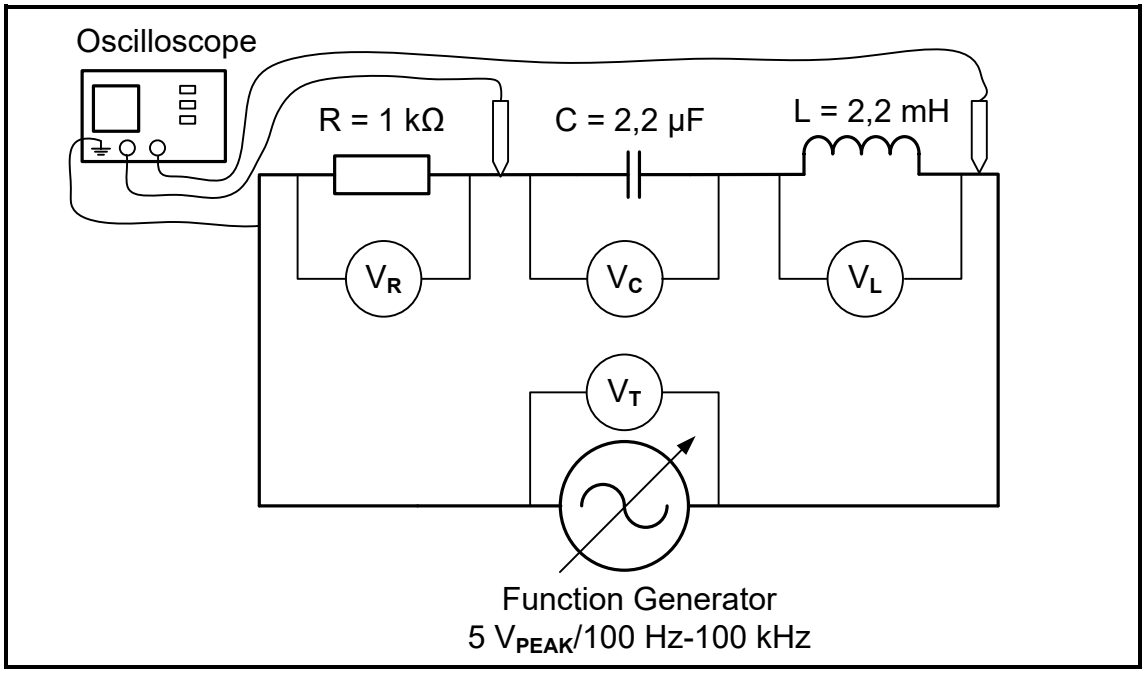
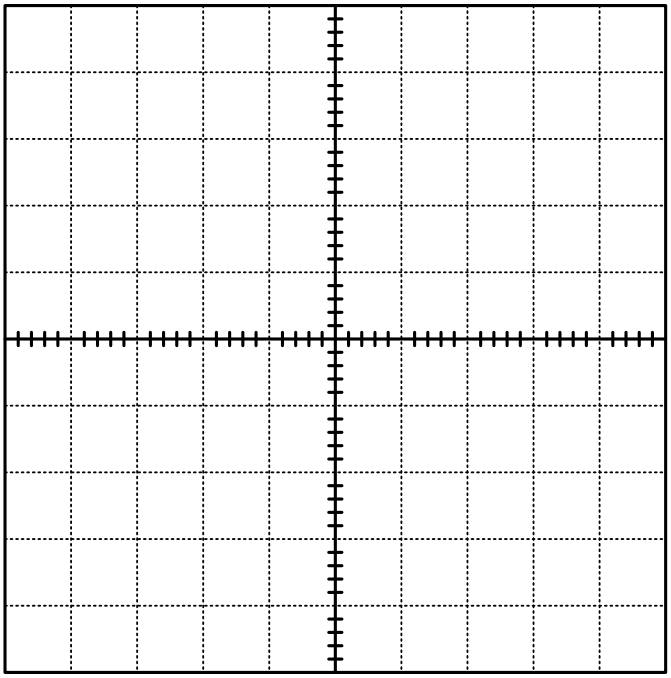


FIGURE 4.1.3

4.1.4 With the supply frequency set to 100 Hz, connect the oscilloscope with the probe of channel 1 across the resistor (V_R) and channel 2 across all components (V_T). Connect the ground terminal of both channels to a common ground.

- Adjust the voltage (vertical) and time (horizontal) settings to display at least two complete cycles.
- Draw and label the waveforms below.
- Use the oscilloscope settings to measure V_R and V_T and record it in the spaces provided below.



CH 1 V/div: _____

CH 2 V/div: _____

Time/div: _____

$V_{R(PEAK)}$:_____

$V_{T(PEAK)}$:_____

FIGURE 4.1.4: OSCILLOGRAM

NOTE: 2 marks for each correctly labelled waveform = 4
1 mark for each oscilloscope setting e.g., voltage and time. = 3
1 mark for each correct voltage measurement = 2 (9)

4.1.5 Calculate the phase angle with the voltage values measured in 4.1.4 on the previous page.

(3)

4.1.6 Draw a fully labelled phasor diagram by using the voltage values measured in 4.1.4 and the phase angle calculated in 4.1.5 above.



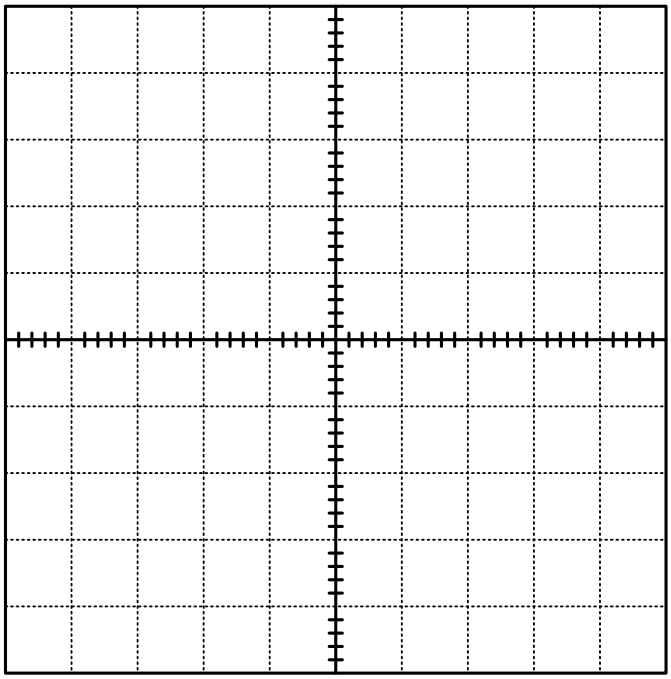
(4)

4.1.7 State whether the circuit is more inductive or more capacitive and motivate your answer.

(2)

4.1.8 Adjust the supply frequency to 50 kHz, connect the oscilloscope with the probe of channel 1 across the resistor (V_R) and channel 2 across all components (V_T). Connect the ground terminal of both channels to a common ground.

- Adjust the voltage (vertical) and time (horizontal) settings to display at least two complete cycles.
- Draw and label the waveforms below.
- Use the oscilloscope settings to measure V_R and V_T and record it in the spaces provided below.



CH 1 V/div: _____

CH 2 V/div: _____

Time/div: _____

$V_{R(PEAK)}$:_____

$V_{T(PEAK)}$:_____

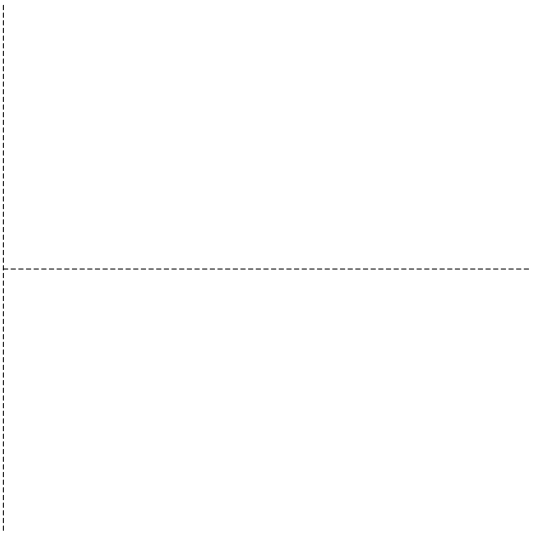
FIGURE 4.1.8: OSCILLOGRAM

NOTE: 2 marks for each correctly labelled waveform = 4
1 mark for each oscilloscope setting e.g., voltage and time. = 3
1 mark for each correct voltage measurement = 2 (9)

4.1.9 Calculate the phase angle by using the voltage values measured in 4.1.8 above.

_____
_____
_____
_____
_____ (3)

4.1.10 Draw a phasor diagram by using the voltage values measured in 4.1.8 as well as the phase angle calculated in 4.1.9 above.



(4)

4.1.11 State whether the circuit is more inductive or more capacitive and motivate your answer.

_____
_____
_____
_____ (2)

4.1.12 Adjust the supply frequency to 2,3 kHz and observe what happens.

4.1.13 Explain the significance of setting the frequency to 2,3 kHz.

_____
_____ (2)

4.1.14 Prove your answer in 4.1.13 by means of a calculation.

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

_____
_____
_____ (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
	Not yet competent after reassessment of certain/all parts of the task	**Competent after reassessment of certain/ all parts of the task**	**Competent**	**Outstanding (Highly competent)**	
To build/connect 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	$/10$
				Theory	$+ \quad /40$
				Total Simulation 1	$= \quad /50$

Copyright reserved

4.2 Simulation 2A: MOSFET used as a switch

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

4.2.1 Purpose:

- To build a circuit on a breadboard
- To demonstrate the operation of a MOSFET transistor used as a switch
- To observe the state of the LED when the input push button is opened and when it is closed

4.2.2 Required resources:

TOOLS/INSTRUMENTS	MATERIALS
Analogue/Digital trainer	2N7000 N-CH MOSFET 60 V 5 ohm
Breadboard	470 Ω resistor x 1
Multimeter	10 kΩ resistor x 1
Power supply 5 V	LED x 1
Side cutters	Push button switch x 1
Wire stripper	Connecting wires

4.2.3 Procedure:

(a) Build the circuit on a breadboard as shown in FIGURE 4.2.3A below.

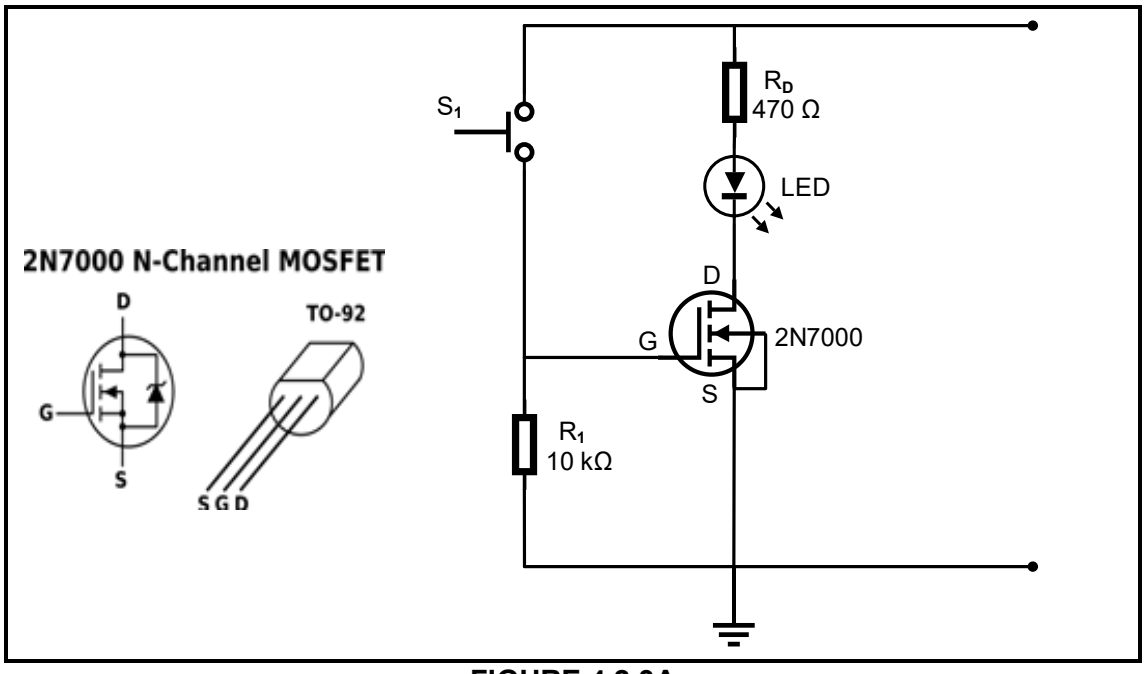


FIGURE 4.2.3A

(b) Connect an ammeter in series with R_D and do the following

(i) Measure the current flow.

_____ (1)

(ii) Measure the voltage across the drain and the source.

_____ (1)

(iii) State the condition of the LED.

_____ (1)

(c) While the ammeter is still connected, press the push button switch S_1 and do the following:

(iv) Measure the current flow.

_____ (1)

(v) Measure the voltage across the drain and the source.

_____ (1)

(vi) State the condition of the LED.

_____ (1)

d) Write a conclusion about a MOSFET, comparing the results in (b) and (c) with reference to the drain current and the drain-source voltage.

_____
_____
_____
_____
_____
_____ (4)

(e) Remove switch (S_1) and replace the 10 kΩ resistor (R_1) with a variable DC power supply as in FIGURE 4.2.3B below.

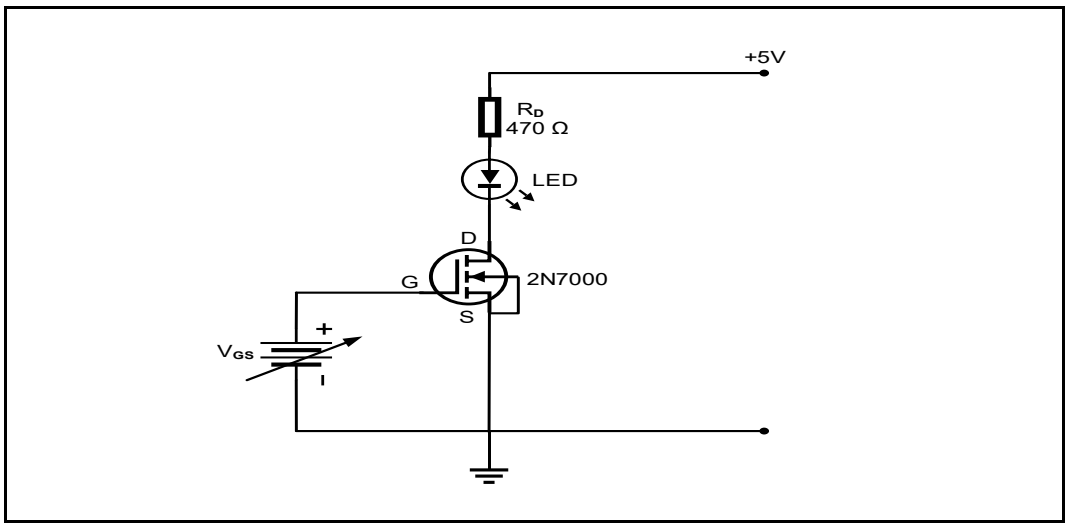


FIGURE 4.2.3B

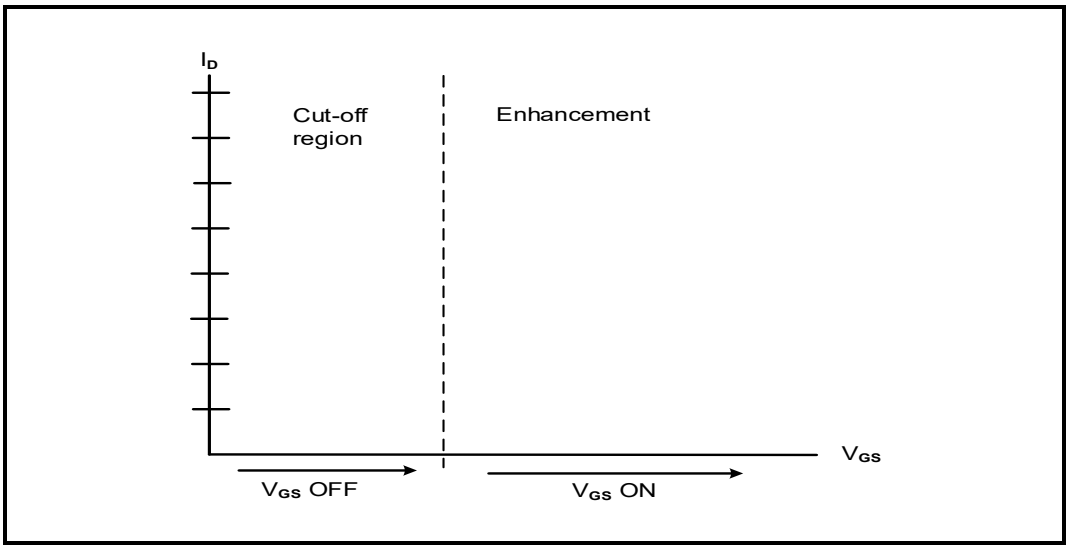
(i) Set the V_{GS} voltage to 0 V and increase the voltage until the LED switches ON.

(ii) Measure the V_{GS} voltage and current flow through the resistor (R_D).

(2)

(iii) Increase the V_{GS} voltage until the current through resistor (R_D) reaches the maximum value. Use this value in the output characteristic curve below

(iv) Complete the output characteristic curve of the circuit in FIGURE 4.2.4B in FIGURE 4.2.4C below. Indicate the minimum and maximum values of the drain current and V_{GS}.



(3)

FIGURE 4.2.4C

NOTE: 1 mark for drawing the graph = 1
1 mark for the maximum drain current = 1
1 mark for the threshold V_{GS} = 1

Simulation 2A (15)

FACET SHEET FOR SIMULATION 2A

Task description	Mark allocation (tick the appropriate level next to the task indicated)				Allocation of marks
	Not yet competent after re-assessment of certain/ all part of the task	**Competent after re-assessment of certain part of the task**	**Competent**	**Outstanding (Highly competent)**	
Connecting up/Building the MOSFET switch 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 learners applied safety rules, regulation, and correct procedure when using tools and instruments to wire the circuits without been reminded by the teacher. **(2)**		$\overline{2}$
Attitude/ Behaviour/ Conduct	The learner was completely 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 instructions, regulation and workshop practice. **(2)**		$\overline{2}$
				Rubric	$\overline{10}$
				Theory	$+\ \overline{15}$
				Total Simulation 2A	$=\ \overline{25}$

Copyright reserved

Simulation 2B: MOSFET used as an amplifier

4.2.4 **Purpose:**

- To connect up the circuit on the breadboard
- To demonstrate the operation of a MOSFET transistor used as an amplifier
- To display the input and output waveforms on an oscilloscope

4.2.5 **Required resources:**

TOOLS/INSTRUMENTS	MATERIAL/COMPONENTS
Analogue/Digital trainer Breadboard Analogue/Digital oscilloscope (dual trace) Function generator Variable DC power supply (split supply) Side cutters Wire stripper Long-nose pliers	2N7000 N-CH MOSFET 60V 5 O ohm 150 Ω resistor x 1 470 Ω resistor x 1 100 kΩ resistor x 1 200 kΩ resistor x 1 0.12 µF ceramic capacitor x 2 Connecting wires

4.2.6 **Procedure:**

- Connect the circuit on the breadboard as shown in FIGURE 4.2.6 below.
- Adjust the function generator to 1 kHz at a voltage of 2V peak to peak.
- Set the oscilloscope up to display at least TWO complete cycles for CH1 and CH2.

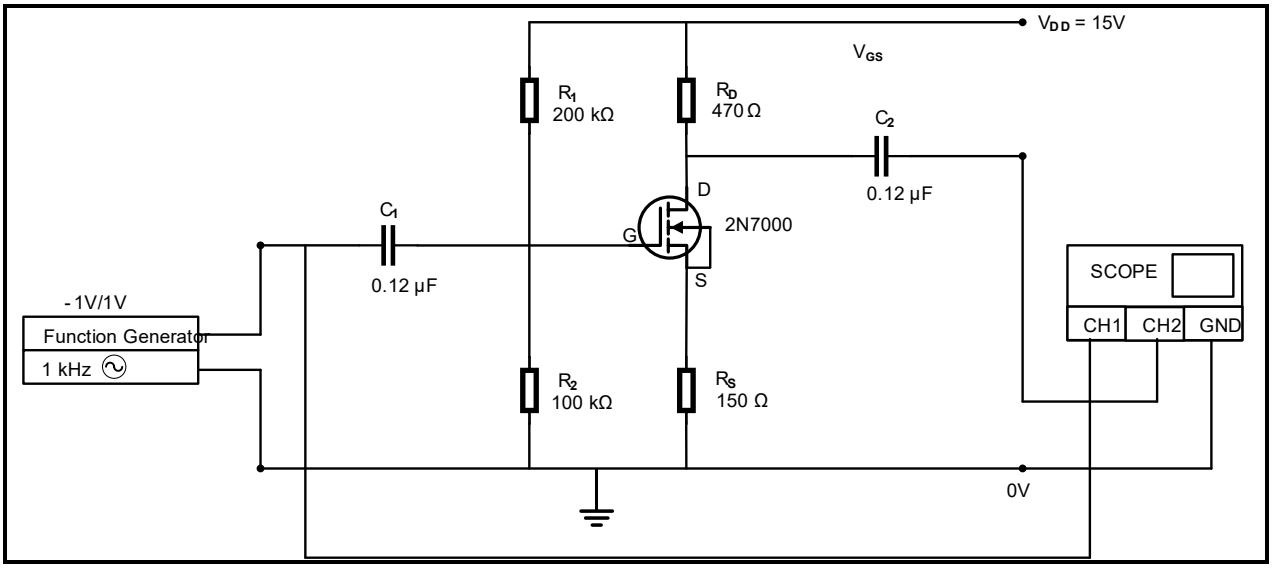
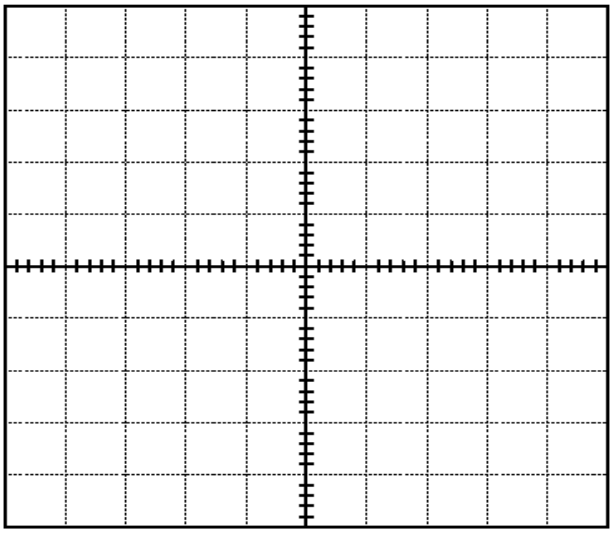


FIGURE 4.2.6

4.2.7 Draw and label both the input (from CH1) and output (from CH2) waveforms for two complete cycles on OSCILLOGRAM 4.2.7 below.



CH 1 V/div: _____

CH 2 V/div: _____

Time/div: _____

V_{IN} : _____

V_{OUT} : _____

OSCILLOGRAM 4.2.7

NOTE: 1 mark for each correct waveform = 2
1 mark for each oscilloscope setting (V/div and Time/div) = 3
1 mark for each voltage measurement = 2 (7)

(a) Compare the input and output waveforms on OSCILLOGRAM 4.2.7 above and write down your observations.

_____
_____
_____
_____ (3)

(b) Measure the voltage across resistor R_1.

_____ (1)

(c) Measure the voltage across resistor R_2.

_____ (1)

(d) Add the two voltages that you obtained from (b) and (c).

_____ (1)

(e) Write a conclusion about R_1 and R_2 when you compare the total voltage in (d) with the supply voltage (V_{DD}).

_____
_____
_____
_____
_____ (2)

Simulation 2B **(15)**

FACET SHEET FOR SIMULATION 2B

Task description	Mark allocation (tick the appropriate level next to the task indicated)				Allocation of marks
	Not yet competent after re-assessment of certain parts/all of the task	**Competent after re-assessment of certain/ all parts of the task**	**Competent**	**Outstanding (Highly competent)**	
Connecting the MOSFET amplifier 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)**	The learner correctly built the circuit without the guidance of the teacher and went beyond expectations and with high proficiency . **(5–6)**	$\overline{6}$
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 learners applied safety rules, regulation, and correct procedure when using tools and instruments to wire the circuits without been reminded by the teacher. **(2)**		$\overline{2}$
Attitude/ Behaviour/ Conduct	The learner was completely 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 instructions, regulation and workshop practice. **(2)**		$\overline{2}$
				Rubric	**/10**
				Theory	**+ /15**
				Total Simulation B	**= /25**
				Total Simulation A	**+ /25**
				TOTAL SIMULATION 2	**= /50**

Copyright reserved

4.3 Simulation 3: Switching circuits using a 555 IC

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

4.3.1 Purpose:

- To build/connect an astable multivibrator circuit using a 555 IC on a breadboard, as shown in FIGURE 4.3.3
- To display the output waveforms on an oscilloscope
- To investigate how a change in R_1 and R_2 affects the frequency and duty cycle of the output

4.3.2 Required resources:

TOOLS/INSTRUMENTS	MATERIALS
Analogue/Digital trainer	1 x 555 IC
Analogue/Digital oscilloscope	1 x 0,1 µF (104) non-polarised
DC power supply	1 x 22 µF (25 V capacitor)
(+9 V)	1 x 330 Ω resistor
Side cutters	1 x 10 kΩ resistor
Wire stripper	1 x 47 kΩ resistor
Long-nose pliers	1 x LED
Breadboard	Connecting wires

4.3.3 Procedure:

Build the circuit in FIGURE 4.3.3 (see next page) on the breadboard.
Connect channel 1 of the oscilloscope across capacitor C_1.
Connect channel 2 of the oscilloscope to pin 3 of the IC.
Switch the circuit ON.
Set the oscilloscope to display at least FOUR complete cycles and observe the output on the oscilloscope. Pay attention to the light from the LED.
Replace resistor R_1 and R_2 as indicated in the simulation question statements.
Answer the questions that follow.

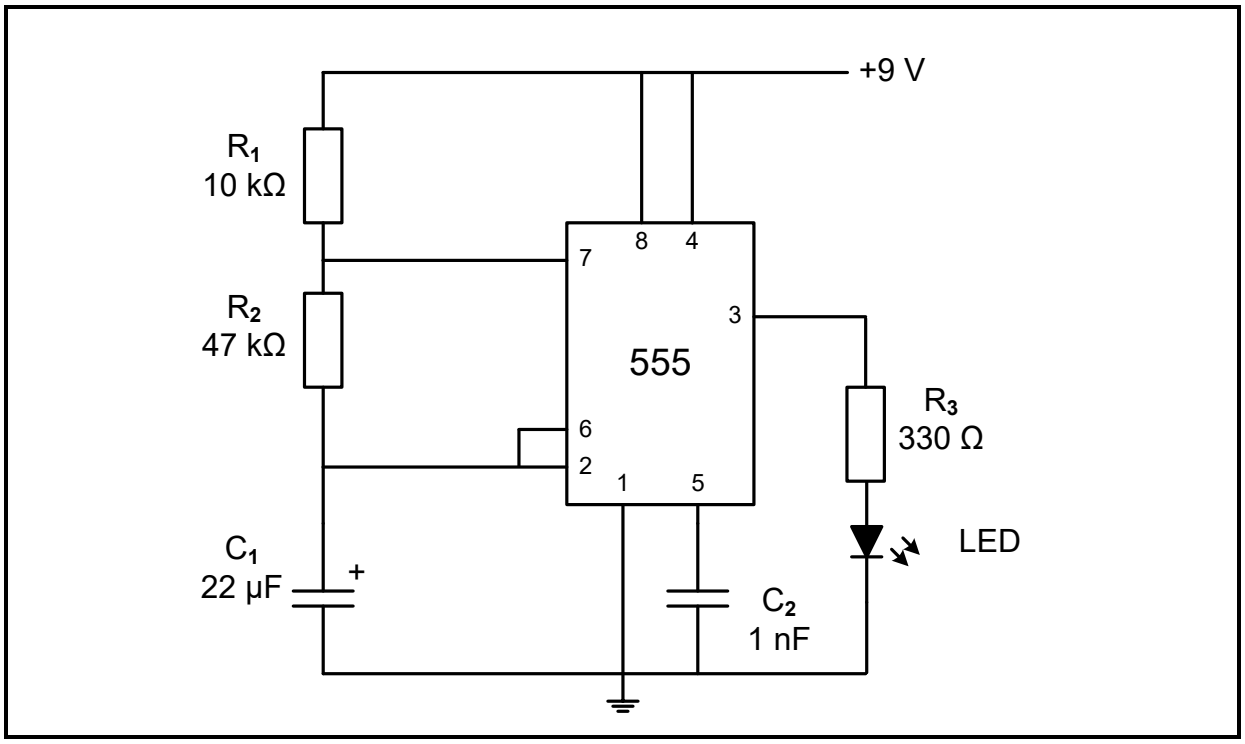
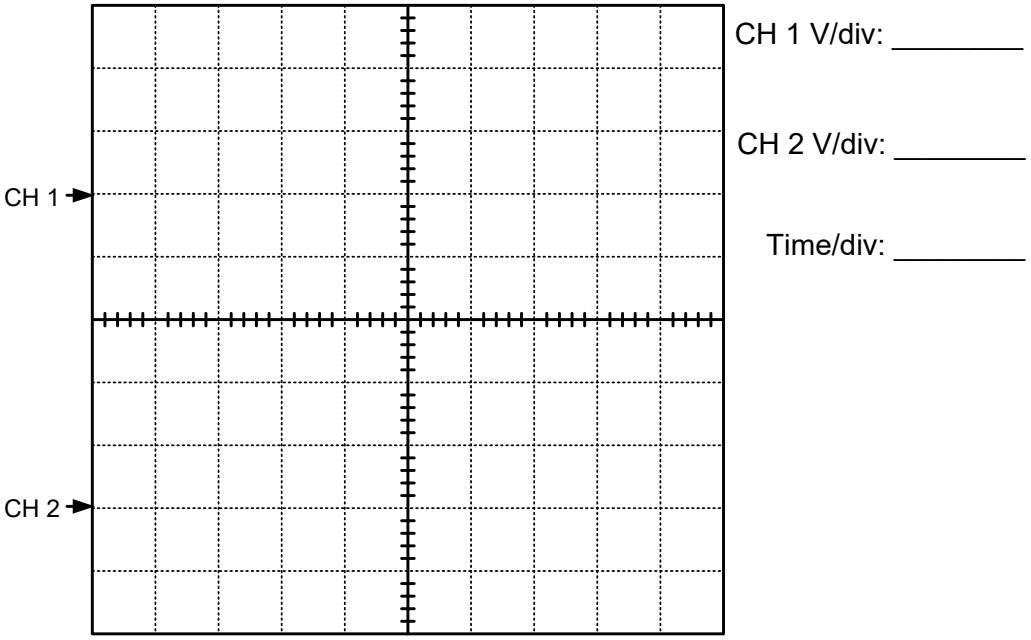


FIGURE 4.3.3: ASTABLE MULTIVIBRATOR CIRCUIT DIAGRAM

PARAMETER	FORMULAE	UNIT
Time high (t_1)	$0{,}693 \times (R_1+R_2) \times C_1$	Second (s)
Time low (t_2)	$0{,}693 \times R_2 \times C_1$	Second (s)
Time period (T)	$T = t_1 + t_2$	Second (s)
Frequency (F)	$f = \frac{1}{T}$	Hertz (Hz)
Duty cycle	Duty cycle$= \frac{t_1}{T} \times 100$	Percentage (%)

4.3.4 Set the oscilloscope to display at least four complete cycles of the output waveform with the amplitudes not smaller than two divisions peak-to-peak. Draw the output waveform, when R_1 = 10 kΩ and R_2 = 47 kΩ, on the oscillogram below.



NOTE: 1 mark for two correct waveform cycles when R_1 = 10 kΩ and R_2 = 47 kΩ (2)
1 mark for correct oscilloscope setting (1) (3)

Calculate the following:

(a) The time that the output is high for each half cycle (Time high t_1)

_____
_____
_____
_____ (3)

(b) The time that the output is low for each half cycle (Time low t_2)

_____
_____
_____
_____ (3)

(c) The period of one cycle

_____
_____
_____
_____ (3)

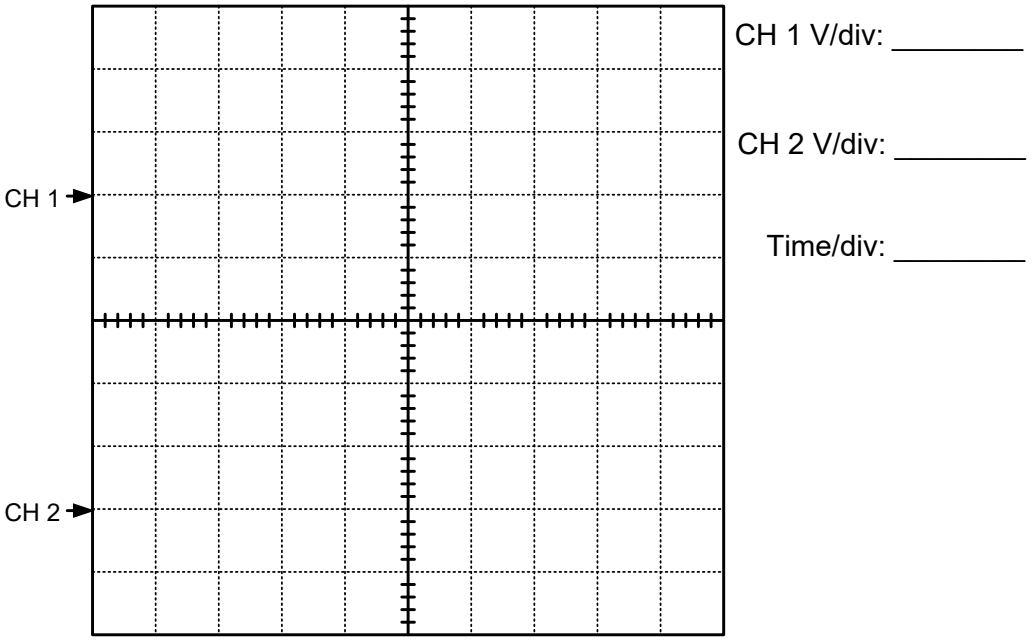
(d) The frequency of the output

_____
_____
_____
_____ (3)

(e) The duty cycle of the waveform

_____
_____
_____
_____ (3)

4.3.5 Set the oscilloscope to display at least four complete cycles of the output waveform with the amplitudes not smaller than two divisions peak-to-peak. Draw the output waveform on the oscillogram below when R_1 = 47 kΩ and R_2 = 10 kΩ,.



NOTE: 2 marks for the correct output waveform
when R_1 = 47 kΩ and R_2 = 10 kΩ (2)
1 mark for correct oscilloscope settings (1) (3)

(a) The time that the output is high for each half cycle (Time high $t_{1)}$

_____
_____
_____
_____ (3)

(b) The time that the output is low for each half cycle (Time low t_2)

_____
_____
_____
_____ (3)

(c) The period of one cycle

_____
_____
_____
_____ (3)

(d) The frequency of the output

_____
_____
_____
_____ (3)

(e) Calculate the duty cycle of the waveform.

_____
_____
_____
_____ (3)

4.3.6 Pay careful attention to the voltage across capacitor C_1 and the LED or the output signal displayed by channel 2 of the oscilloscope. Refer to the voltage across the capacitor and explain when the output changes states.

_____
_____
_____ (2)

4.3.7 Refer to C_1, R_1 and R_2 and explain why the duty cycle in 4.3.4 is different from the duty cycle in 4.2.5.

_____
_____
_____ (2)

Simulation 3 (40)

FACET SHEET FOR SIMULATION 3

Task description	Mark allocation (tick the appropriate level next to the task indicated)				Allocation of marks
	Not competent after re-assessment of certain/all parts of the task	**Competent after re-assessment of certain/ all parts of the task**	**Competent**	**Outstanding (Highly competent)**	
Building/ Connecting the astable multivibrator using a 555 IC	The learner was given opportunities to rebuild the circuit after the teacher intervened in identifying and rectifying more mistakes. **(1)**	The learner was given an opportunity to re-build 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 learners applied safety rules, regulation, and correct procedure when using tools and instruments to wire the circuits without been reminded by the teacher. **(2)**		$\overline{2}$
Attitude/ Behaviour/ Conduct	The learner was completely 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 instructions, regulation and workshop practice. **(2)**		$\overline{2}$
				Rubric	$\overline{10}$
				Theory	$+\ \overline{40}$
				Total Simulation 3	$=\ \overline{50}$

Copyright reserved

4.4 Simulation 4: Two-stage RC-coupled amplifier

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

4.4.1 Purpose:

- To build a two stage RC coupled CE amplifier circuit using discrete components and displaying the input/output waveforms on an oscilloscope
- To measure the input and the output voltage
- To measure/calculate voltages
- To calculate the voltage and the current gain in decibels

4.4.2 Required resources:

TOOLS/INSTRUMENTS	MATERIALS
Analogue/Digital trainer Analogue/Digital oscilloscope Function generator Multimeter Variable DC power supply Side cutters Pair of pliers Wire strippers	Resistors ½ W: 1x 1 kΩ for R_1 1 x 100 Ω for R_2 2 x 180 Ω for R_3 and R_7 2 x 22 kΩ for R_4 and R_8 4 x 15 kΩ for R_5, R_6, R_9 and R_{10} 1 x 47 kΩ for R_{11} 2 x BC 337 transistors Capacitors: 1 x 1 µf /25 V capacitor for C_1 3 x 22 µf /25 V capacitors for C_2, C_3 and R_{10}

4.4.3 Procedure:

- Connect up a two-stage RC coupled amplifier circuit diagram, as shown in FIGURE 4.4.3, on the breadboard or digital trainer using discrete components.
- Connect channel 1 of the oscilloscope across resistor R_2 to observe the input wave form of the circuit.
- Connect channel 2 of the oscilloscope on node A, across resistor R_8, to observe the output wave form of the first stage of circuit.
- Measure the input current to the circuit with ammeter A_1 and ammeter A_2..
- Connect the emitter capacitor parallel with resistor R_{10} and observe the effect that the capacitor has on the output signal of the circuit.
- Measure the output voltage of the circuit with the emitter capacitor connected and observe the change in output voltage.

Copyright reserved

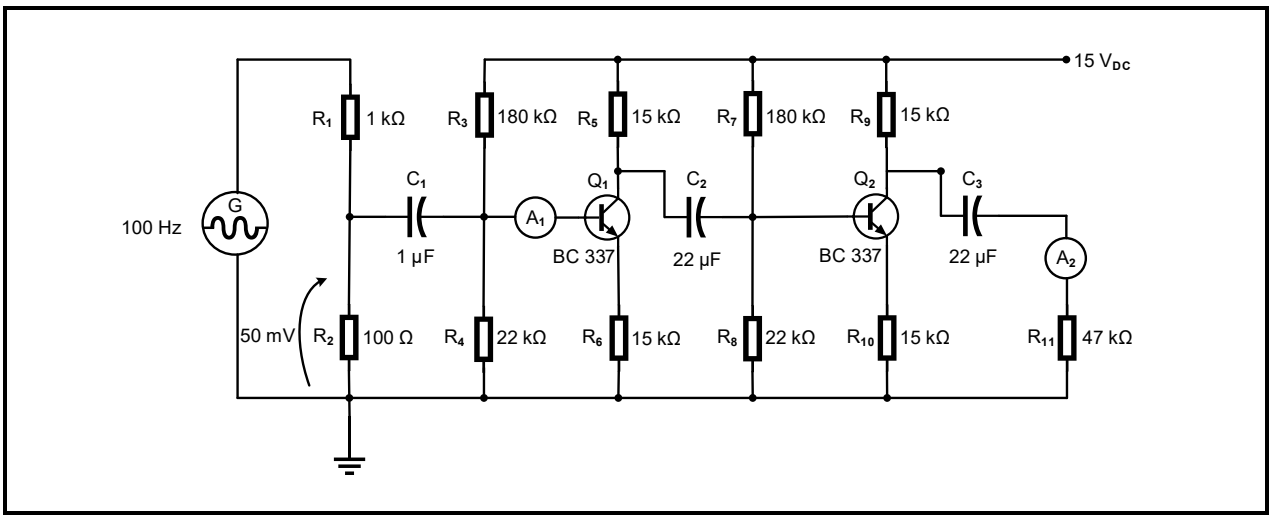
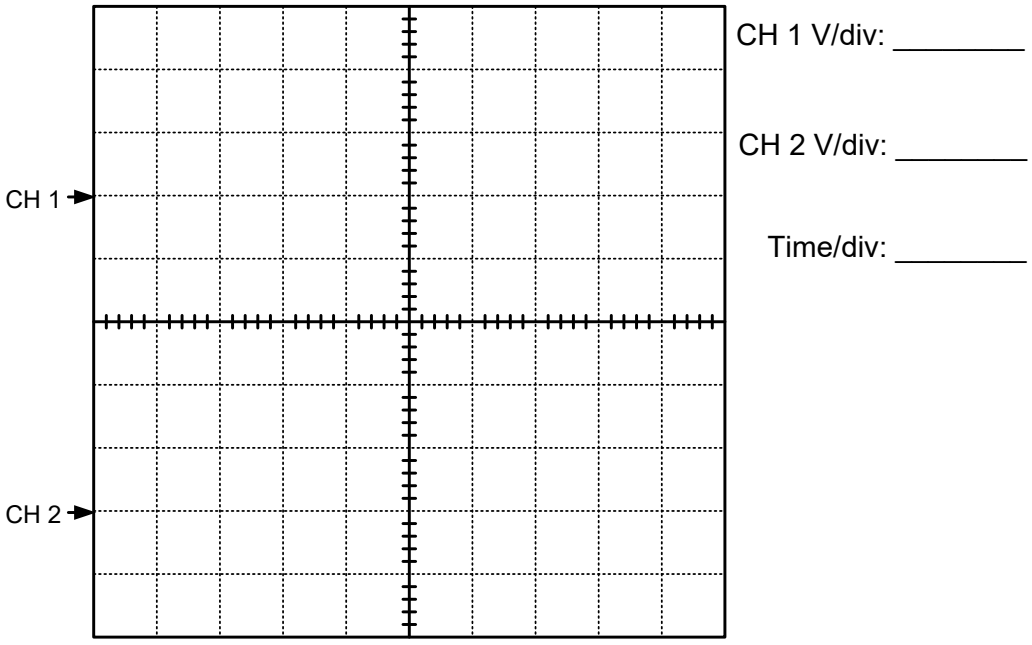


FIGURE 4.4.3: TWO-STAGE RC COUPLED AMPLIFIER

4.4.4 Set the oscilloscope to display the waveforms of the first stage and the second stage waveforms with the amplitudes not smaller than 2 divisions peak-to-peak when the input voltage is 150 mV on the oscillogram below.



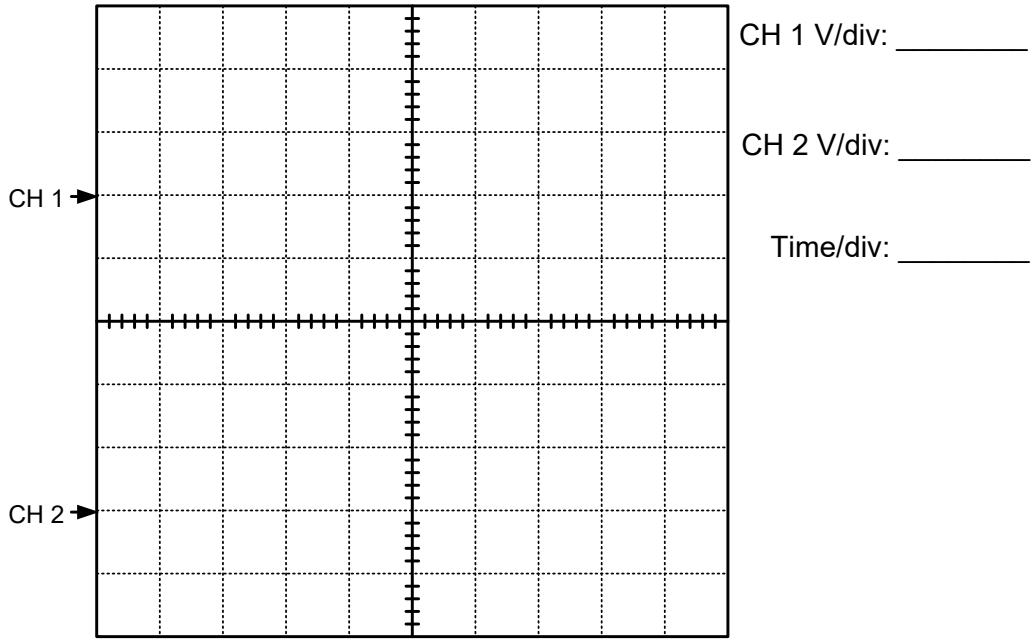
NOTE: 2 marks for the correct waveforms (2)
3 marks for the correct oscilloscope settings (3) (5)

4.4.5 Measure the input voltage and the output voltage at node A of the circuit.

Input voltage: _____

Output voltage: _____ (2)

4.4.6 Draw ONE complete input and output cycle of the waveform across resistor R_{11} of the circuit on the provided oscillogram diagram below, when the input voltage is 50 mV. Clearly distinguish between the two signals by the setting of the oscilloscope.



NOTE: 2 marks for the input and output waveforms cycles (2)
3 marks for oscilloscope settings, e.g. voltage and time (3) (5)

4.4.7 Measure the input voltage across R_2 and the output voltage across resistor R_{11} of the circuit.

Input voltage: _____

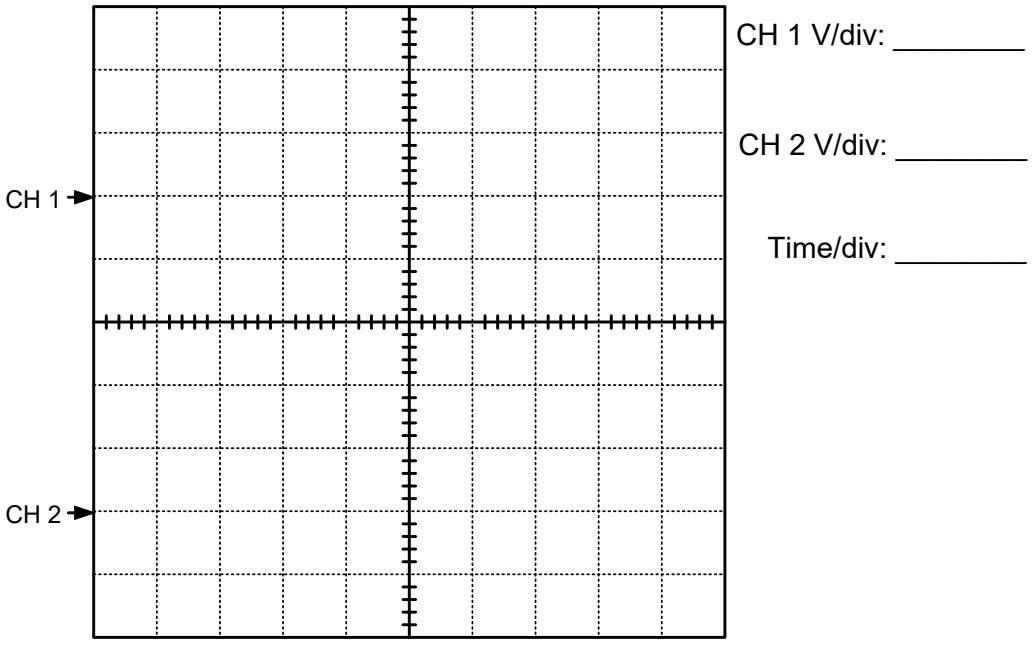
Output voltage: _____ (2)

4.4.8 Measure the input current at ammeter 1 and the output current at ammeter 2 when the input voltage to the circuit is 50 mV.

Ammeter 1: _____

Ammeter 2: _____ (2)

4.4.9 Connect a 22 uf capacitor in parallel with resistor R_{10} and observe the reaction of the output waveform of the circuit. Draw your observation of one complete cycle of an output waveform on the oscillogram below. Do the necessary adjustments to the oscilloscope to obtain a clear wave form.



NOTE: 1 mark for the output waveform (1)
2 marks for setting channel 2 and time/div (2) (3)

4.4.10 Measure the input voltage and the output voltage across resistor R_{11} of the circuit with the emitter capacitor connected across R.

Input voltage: _____

Output voltage: _____ (2)

4.4.11 Measure the input current at ammeter 1 and the output current at ammeter 2, with the emitter capacitor connected across R_{10}, when the input voltage is 50 mV.

Ammeter 1: _____

Ammeter 2: _____ (2)

4.4.12 Explain the function of the emitter capacitor (C_E) connected across emitter resistor R_{10} in stage 2 of the circuit diagram in FIGURE 4.4.3.

_____

_____

_____ (1)

4.4.13 Calculate the voltage gain of the circuit in decibels, making use of the values obtained in QUESTION 4.4.5.

(3)

4.4.14 Calculate the current gain of the circuit in decibels, making use of the values obtained in QUESTION 4.4.8.

(3)

4.4.15 Explain the output waveform obtained in QUESTION 4.4.9 when the emitter capacitor was connected across the emitter resistor.

(3)

4.4.16 Explain the term *impedance matching* with reference to the circuit diagram in FIGURE 4.4.3.

(2)

Copyright reserved

FACET SHEET FOR SIMULATION 4

Task description	Mark allocation (tick the appropriate level next to the task indicated)				Allocation of marks
	Not competent after reassessment of certain/all parts of the task	**Competent after reassessment of certain/ all parts of the task**	**Competent**	**Outstanding (Highly competent)**	
Connecting (up) the two-stage RC coupled amplifier	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. **(2–5)**	The learner correctly built the circuit without the guidance of the teacher. **(6–8)**	The learner correctly built the circuit without the guidance of the teacher and went beyond expectations and with high proficiency. **(11)**	$\overline{\mathbf{11}}$
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 learners applied safety rules, regulation, and correct procedure when using tools and instruments to wire the circuits without been reminded by the teacher. **(2)**		$\overline{\mathbf{2}}$
Attitude/ Behaviour/ Conduct	The learner was completely reluctant at all 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 instructions, regulation and workshop practice. **(2)**		$\overline{\mathbf{2}}$
				Rubric	$= \overline{\mathbf{15}}$
				Total Simulation 4	$+ \overline{\mathbf{35}}$
				TOTAL:	$= \overline{\mathbf{50}}$

Copyright reserved

5. SECTION B: DESIGN AND MAKE

Design and Make Project

Time: January to August 2026

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	☐	☐

Copyright reserved

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: ● Freehand sketches (2) ● EGD equipment (5) ● 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.	PCB layout designed with the use of computer software (4 marks) PCB layout designed with the use of etching pens/ Veroboard layout designed on paper (3 marks)	4	
18.	Transfer of the PCB design onto the blank board is correct. Not over-exposed or under-exposed.	5	
19.	Circuit board is etched neatly according to the PCB design.	10	
20.	The learner's name is etched onto the circuit design.	4	
21.	All burrs are removed.	2	
22.	Axial and radial components are placed neatly and flush with the board.	5	
23.	Component orientations are aligned between similar components (e.g. the gold band of all resistors are placed on the same side).	2	
24.	Soldered components – leads are cut off, flush and neat on the solder side.	5	
25.	More than 60% of the solder joints are shiny (not dry joints).	5	
26.	Wire insulation is stripped to the correct length (no extra copper showing).	3	
27.	Wiring is long enough to allow for dismantling and inspection.	2	
28.	Wiring is wrapped neatly.	2	
29.	A power switch is included and fitted to the enclosure.	2	
30.	A fuse/protection is included and fitted correctly where applicable.	2	
31.	Wiring entering/exiting the enclosure is provided with a grommet/applicable fittings/socket where applicable.	2	
32.	Batteries/Transformer is mounted using a battery housing/ mounting bracket and battery clip (NO double-sided tape).	2	
33.	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	
34.	The project is fully operational and commissioned/installed in the enclosure.	6	
	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.

Copyright reserved

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.
- Include the placement of ALL components/meters and holes to your drawing.
- 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 are 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. Perfectly manufactured square, neat and sturdy enclosure (5) Injection moulded/pre-manufactured enclosures minimum alterations. (3) Enclosures may include sheet metal, Perspex, Plexiglas, wood, glass and other raw materials, injection-moulded plastic boxes Enclosures may NOT include cardboard, paper, margarine container.	5	
12.	Holes/Cut-outs in the enclosure are made with the appropriate tools and match the design.	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

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 one purchases, outputs more than the specified value, so be careful when choosing the transformer.

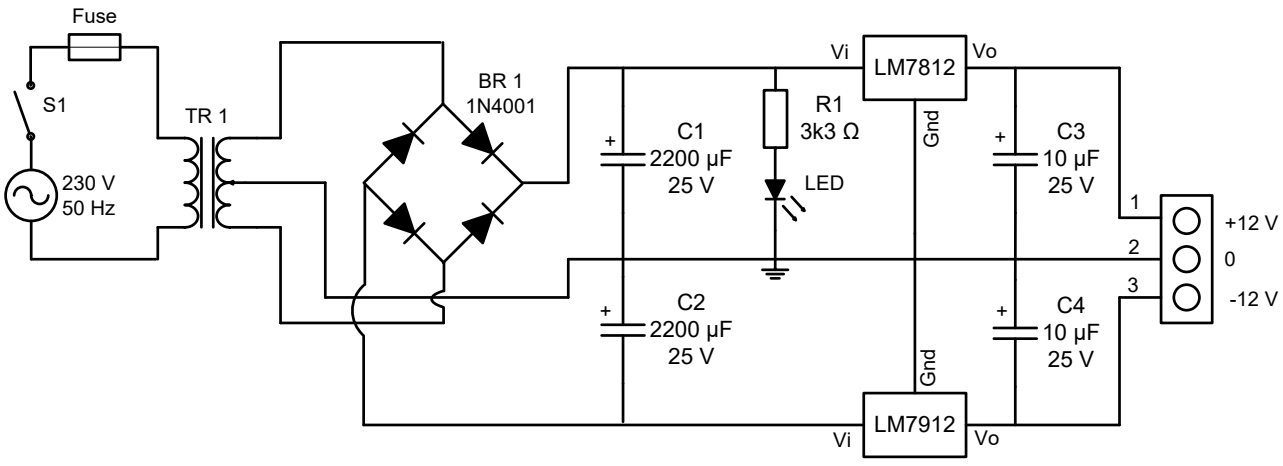
Capacitors C1 and C2 act as smoothing capacitors. This is to even out any fluctuation in voltage. You can also add a bypass capacitor after the C1 and C2 to remove any AC noise, which is not shown in the circuit. Next the two voltage regulators: the 7812 gives positive 12 V and the 7912 gives negative 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, cleaner DC signal.

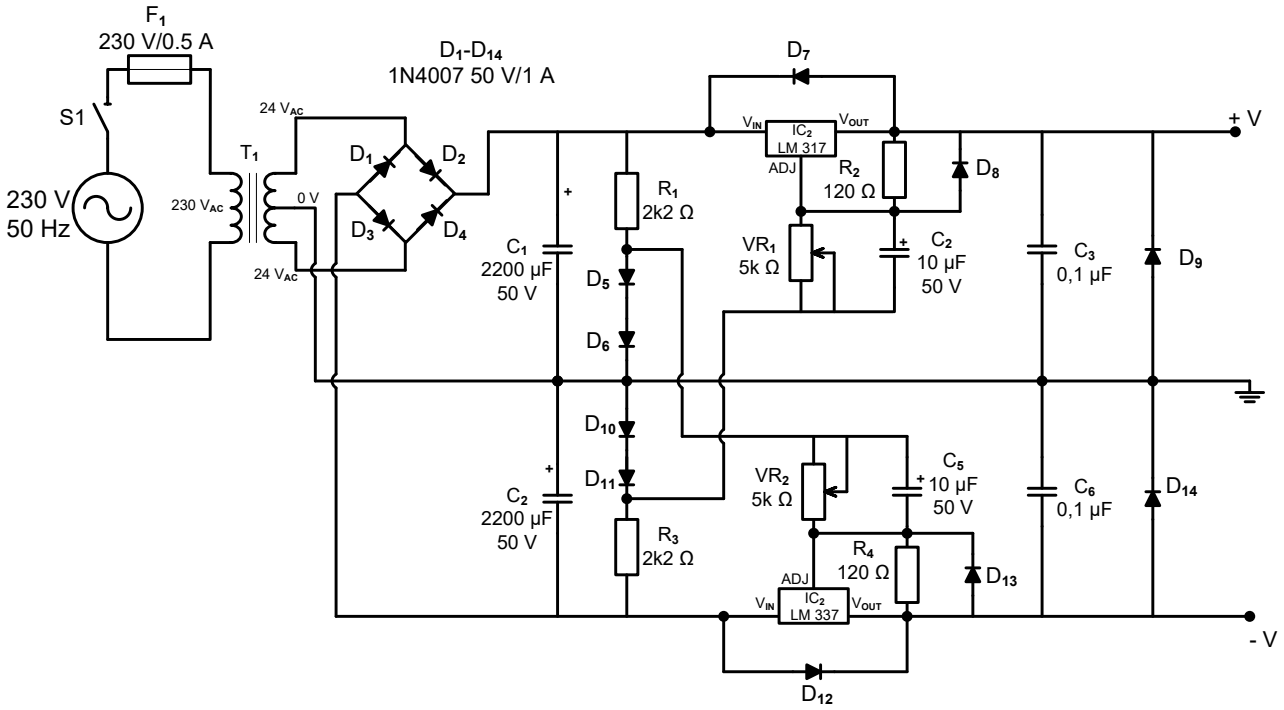
Resources required:

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 3-2mm – power chord 1 x Cabtyre – ½ metre 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.

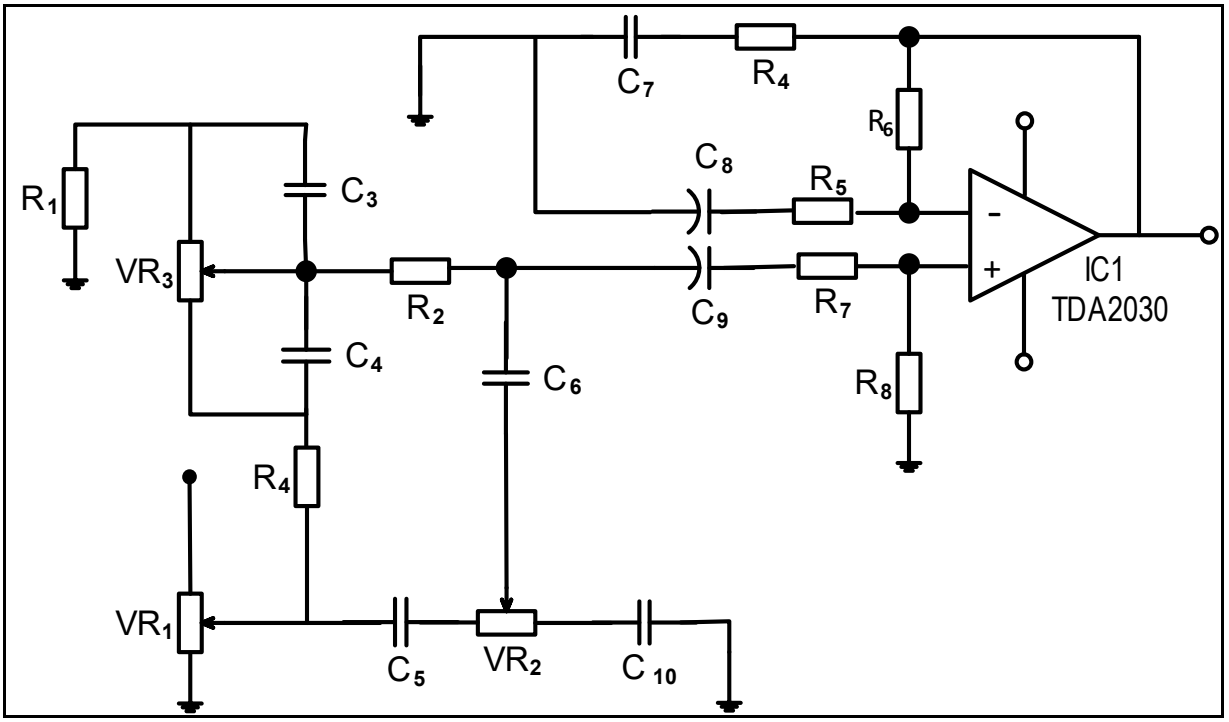
Copyright reserved

6.2 Practical Project: TDA2030 Audio Amplifier with bass, treble and tone control

Resources required:

TOOL	MATERIALS	
Multimeter Side cutters Wire strippers Soldering iron Helping Hands PCB etching tank or similar Solder sucker	VR1 volume VR2 treble VR3 bass C1, C2, C3, C4 C5 C6 C7 C8 C9 C10 R1, R2, R3 R4 R5 R6 R7, R8 IC1	50 kΩ 50 kΩ 50 Ω 470 nF film/ceramic 1 nF film/ceramic 22 nF film/ceramic 470 nF film/ceramic 10 µF/16 V electrolytic 22 µF/16 V electrolytic 22 nF film/ceramic 4,7 kΩ 47 Ω 390 Ω 20 kΩ 1 kΩ TDA 2030 audio amplifier IC

Circuit diagram: TDA2030 Audio Amplifier with bass, treble and tone control



PART NUMBER	DESCRIPTION	QTY
VR1 volume	50 kΩ	1
VR2 treble	50 kΩ	1
VR3 bass	50 kΩ	1
C1, C2, C3, C4	470 nF film/ceramic	4
C5	1 nF film/ceramic	1
C6	22 nF film/ceramic	1
C7	470 nF film/ceramic	1
C8	10 µF/16 V electrolytic	1
C9	22 µF/16 V electrolytic	1
C10	22 nF film/ceramic	1
R1, R2, R3	4,7 kΩ	3
R4	47 Ω	1
R5	390 Ω	1
R6	20 kΩ	1
R7, R8	1 kΩ	2
IC1	TDA2030 Audio Amplifier IC	1
Power	Power supply (15V–18VDC)	1
Heat sink	For TDA2030	1
Speaker	Speaker 4Ω–8Ω	1
Audio jacks	3.5 mm stereo or RCA	1
Enclosure	Pre-cut wood + Perspex/Plastic	1
Power indication + Protection	ON/OFF switch with light, fuse holder, fuse	1
PCB suspension	PCB stand-off's + nuts + bolts	2
Connecting wire	Connecting wire	1

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.

Copyright reserved