basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

ELECTRICAL TECHNOLOGY (ELECTRONICS)

GUIDELINES FOR PRACTICAL ASSESSMENT TASKS

GRADE 12

2020

These guidelines consist of 51 pages.

TABLE OF CONTENT

1. INTRODUCTION

The 17 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
- 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 or more simulations and a practical project. The teacher may choose any one of the practical projects and any four simulations available for power systems.

The teacher must apply assessment on an ongoing basis at the same time that the learner is developing the required skills. Four 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

Each learner must present the following:

- PAT file with all the evidence of simulations, design and prototyping. A copy of the PAT 2020 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 and metal enclosures are acceptable.
    - The enclosure should be accessible for scrutiny inside.
    - Lids that are secured with screws 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.
  - 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.
  - Logo and name must be prominent on the enclosure.

The PAT will have a financial impact on the school's budget and school management teams are required to make provision to accommodate 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 progressing 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 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 it 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 it.

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 re-assessment 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 Assessment Management Plan

The assessment plan for the PAT is as follows:

TIME FRAME	ACTIVITY	RESPONSIBILITY
	Preparation for PAT 2020	Teacher – Builds the models and works out the model answers for the simulations for 2020. Identifies shortages in tools, equipment and consumable items for simulations that must be procured in 2020 SMT – Receives procurement requests from teachers and processes payments for the acquisition of required items
January–March 2020	Simulations 1 and 2	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 holiday
January 2020	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 in on teacher to see if the process is adhered to
February 2020	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 – Includes practical sessions for learners to complete the PAT project every week Learners – Commence with completion of the PAT project HOD – Checks in on teacher to ensure that practical workshop sessions take place on a weekly basis
April–June 2020	Moderation of Simulations 1 and 2	District subject facilitator/subject specialist will visit the school and moderate Simulation 1 and 2 10% of learners' work is moderated
April–June 2020	Simulations 3 and 4	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 holiday
April–June 2020	PAT project – learners continue with project	Teacher – Ensures that there is secure storage for PAT projects Teacher – Hands out and takes in PAT projects Teacher – Includes practical sessions for learners to complete the PAT project every week 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 2020	PAT intervention	Learners that are behind on the PAT are required to complete the project during this holiday.
July–August 2020	Moderation of Simulations 3 and 4	District subject facilitator/subject specialist will visit the school and moderate Simulations 3 and 4 – different learners from the previous term 10% of learners' work is moderated
July–August 2020	PAT project – completion	Teacher – Ensures that there is secure storage for PAT projects Teacher – Hands out and takes in PAT projects Teacher – Completes the PAT project with learners and compiles the PAT file Learners – Complete the PAT project and file HOD – Checks to see that 100% of the PAT files and projects are completed and assessed
September–October 2020	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

2.4 Moderation of PATs

Provincial moderation of each term's simulations will start as early as the following term. Simulations 1 and 2 should be moderated as soon as the second term starts. Similarly, Simulations 3 and 4 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 for 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 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 it for the learners to practice 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 the provided examples.
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 are working with it.
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 from schools and subject advisors. The projects are based on working prototypes and require careful construction in order for it to operate correctly.

Projects are varied in cost and teachers must ensure that the projects chosen 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 file correctly.

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

2.8 Working marks sheet

(A working Excel file is provided with this PAT)

PAT Mark Sheet		Term 1		Term 2		Project		Total = Term 1 + Term 2 + Project 250	Mark out of 100	Moderated Mark
No.	Name of Learner	Simulation 1 40	Simulation 2 40	Simulation 3 40	Simulation 4 40	Design and Make Part 1 70	Design and Make Part 2 20			
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:______________________

School Stamp

3. LEARNER GUIDELINES

PAT 2020 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 (2020)

Learner Name: ______________________________

Class: ______________________________

School: ______________________________

Specialisation: **ELECTRONICS**

Complete FOUR simulations.

Project (Write the name of the project): ______________________________

Evidence of moderation:

NOTE:
When the learner evidence (LE) 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				
Provincial moderation			Re-moderation	

Mark allocation

PAT Component	Maximum Mark	Learner Mark	Moderated Mark
Simulation 1	40		
Simulation 2	40		
Simulation 3	40		
Simulation 4	40		
Design and Make Project – Circuit	70		
Design and Make Project – Enclosure	20		
Total	**250**		

3.1 Instructions to learners

- 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 is not allowed.
- The practical assessment task must be completed over three quarters.
- The PAT file must contain 4 simulations and a practical project.
- Calculations should be clear and include units. Calculations should be rounded off to TWO digits. 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 can 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

3.2 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: ________________________________

Mark ____ / 40

Class: ____________ **Date Completed:** ________________

Date Assessed: ________________ **Assessor Signature:** ______________

Date Moderated: _______________ **Moderator Signature:** _______________

4.1.1 PURPOSE:

- To build a RLC-series circuit
- To measure the total current of a series RLC-circuit over a wide range of frequencies
- To display the voltage waveforms across different components and observe the relationships between the voltages

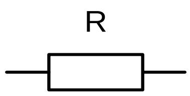
4.1.2 COMPONENT LIST

- Any audio transformer (interstage impedance matching transformer found in modems, audio circuits – value is not critical)
- 0,1 µF capacitor (104)
- 1kΩ (Brown Black Red 5% – ¼ Watt)
- Function generator (Disconnect the earth terminal of the function generator.)
- Experiment board
- Connecting wires
- 4 x multimeters
- Oscilloscope with two probes (Disconnect the earth terminal of the oscilloscope.)

4.1.3 RLC SERIES CIRCUIT

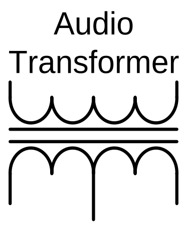
(a) Measure the exact value of following components before connecting the circuit:

The exact resistance of R (Will differ slightly from learner to learner):



R = _______________ (1)

The exact resistance of L (The resistance of the coil being used):



R_L = _______________

(1)

(b) Build the circuit diagram in FIGURE 4.1 on your experiment board. You will be assessed using the rubric below.

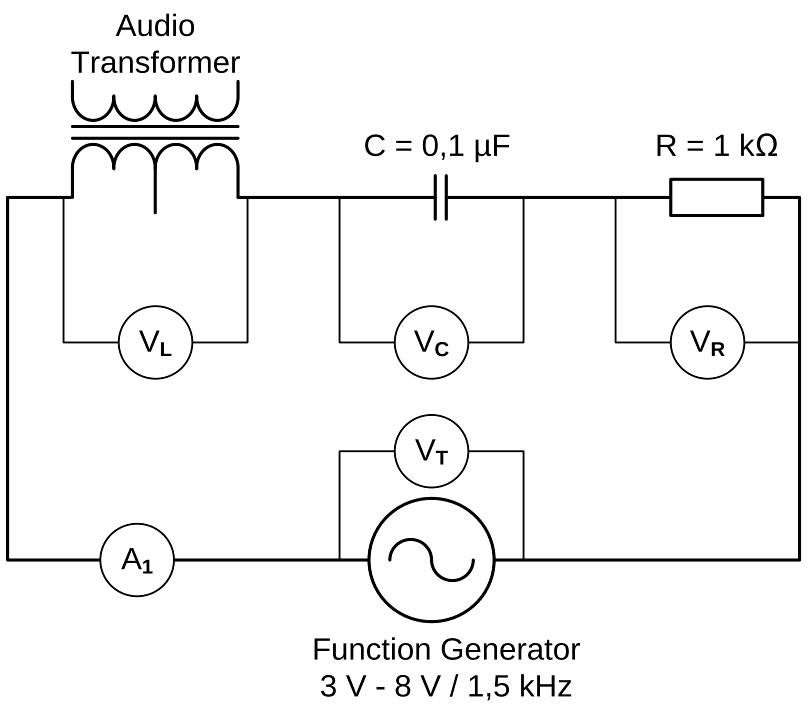


FIGURE 4.1

LEVEL DESCRIPTOR				MARKS OBTAINED
0	**1**	**2**	**4**	
The candidate was not able to construct the circuit on his own.	The candidate was able to partially construct the circuit on his own.	The candidate was able to correctly construct the circuit with the assistance of the teacher.	The candidate constructed the circuit correctly without the assistance of the teacher.	
The candidate was not able to connect the measuring instruments.	The cadidate was able to partially connect the measuring instruments to the circuit.	The candidate connected the measuring instruments correctly and measured the voltages and currents with the assistance of the teacher.	The candidate connected the measuring instruments correctly and measured the voltages and currents on his own.	

(8)

4.1.4 PROCEDURE

(a) Set the function generator to a sine wave and adjust the voltage to between 3–8 V sine wave. (Set the voltage as high as the frequency generator allows.)

NOTE: Once the voltage is set, do NOT change the amplitude of the voltage.

Set the frequency. Teachers are requested to change the frequency for each learner. Use frequency intervals in such a manner that each learner has a unique frequency. (Teachers should choose frequencies where the required reaction (reactance) from the circuit is evident. This is dependent on the value of the coil, which is determined by the components chosen.)

Write down the frequency assigned to you:

f = ____________

NOTE: Do NOT adjust the frequency unless instructed to do so.

(b) Connect the multimeters to reflect the following:

V_L = ________________________________
V_C = ________________________________
V_R = ________________________________
V_T = ________________________________
I_T = ________________________________

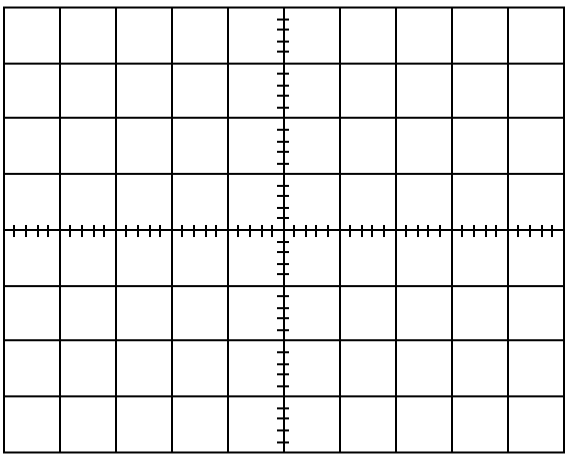
(Meters must be true RMS meters set to AC to ensure correct readings.) (5)

(c) Calculate the total current in the circuit using V_R and the measured value of $(R+R_L)$.

$V_R = I_T \times (R+R_L)$ ____________________
____
__________________________________ (2)

(d) Draw the TWO waveforms displayed on the oscilloscope screen to illustrate the phase relationship between V_R and V_L .

NOTE: Schools that have digital scopes can make screenshots and print the screenshot. Learners may NOT copy from each other.



V/Div:___________ (Ch 1)

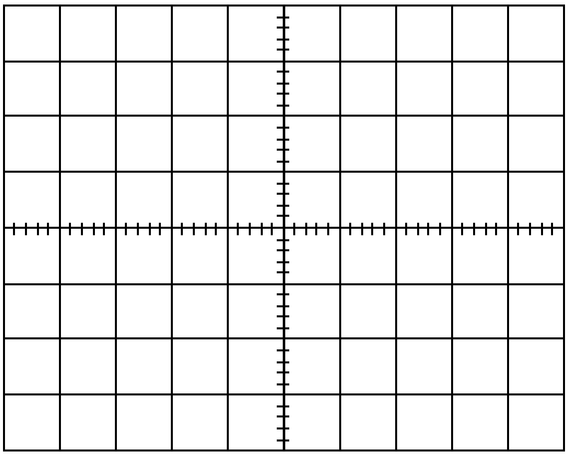
V/Div:___________ (Ch 2)

T/Div: ___________

NOTE:
1 mark for each waveform correctly drawn and 1 mark for the oscilloscope settings.

(3)

(e) Draw the TWO waveforms displayed on the oscilloscope screen to illustrate the phase relationship between V_R and V_C.



V/Div:____________ (Ch 1)

V/Div:____________ (Ch 2)

T/Div: ____________

NOTE:
1 mark for each waveform correctly drawn and 1 mark for the oscilloscope settings.

(3)

(f) Calculate the impedance of the circuit (Z).

(3)

(g) Calculate X_C by using the specific frequency assigned to you in QUESTION 4.1.3.

(3)

(h) Calculate the total reactance X using R and R_L:

R_L = resistance of the inductor measured in QUESTION 4.1.4(b)

$$X = \sqrt{Z^2 - (R + R_L)^2}$$

(2)

(i) Calculate the inductive reactance (X_L) from X and X_C.

$$X_L = X - X_C$$

(2)

(j) Calculate the inductance of the coil (L) from X_L.

(3)

(k) Tabulate your values in the following table and compare it with the given results:

Learner Results

V_{COIL}	V_C	V_T	V_R	I_T	R	Z	X	X_L	X_C	L

Typical Values

V_{COIL}	V_C	V_T	V_R	I_T	R	Z	X	X_L	X_C	L
6,6 V	4,5 V	7,9 V	3,1 V	3,1 mA	1 000 Ω	2 548 Ω	-	740 Ω	1 592 Ω	117 mH

(l) State whether the frequency of the supply must increase or decrease for the circuit to resonate. Motivate your answer.

____

____

____

____ (2)

(m) Explain how the voltages in a RLC series circuit can be leading and lagging. Why is the reference made to the phase shift of the voltages and not current in this instance?

____

____ (2)

4.1.5 CONCLUSION:

In a series AC circuit the current is equal in all components.

The voltage across the inductor leads the supply voltage and the voltage across the capacitor lags the supply voltage.

TOTAL: 40

4.2 Simulation 2: Semiconductors – JFET amplifier and a Darlington pair

Name of learner: ________________________________

Mark ____ / 40

Class: ____________ **Date Completed:** ________________

Date Assessed: ________________ **Assessor Signature:** ________________

Date Moderated: _______________ **Moderator Signature:** _______________

4.2.1 PURPOSE:

Construct an amplifier using a JFET and investigate the advantage of using a Darlington pair compared to a single transistor. Display the input/output waveforms on an oscilloscope.

Activity 2A: Construct a circuit using a JFET as an amplifier

4.2.2 REQUIRED RESOURCES:

TOOLS/INSTRUMENTS	MATERIALS
• Analogue/Digital trainer • Analogue/Digital oscilloscope • Function generator • Variable DC power supply • Side cutters • Wire stripper • Multimeter	• 2 x 1 kΩ resistor • 1 x 100 Ω resistor • 1 x 2M2 Ω resistor • 1 x 5k6 Ω resistor • 1 x 4k7 Ω resistor • 1 x 220 nF capacitor • 1 x 22 μF capacitor 32 V • 1 x 10 μF capacitor 32 V • 1 x 2N3819 JFET (2N5459 or 2N5457) • Connecting wires

4.2.3 PROCEDURE:

(a) Build the circuit in FIGURE 4.2 on an experiment board.

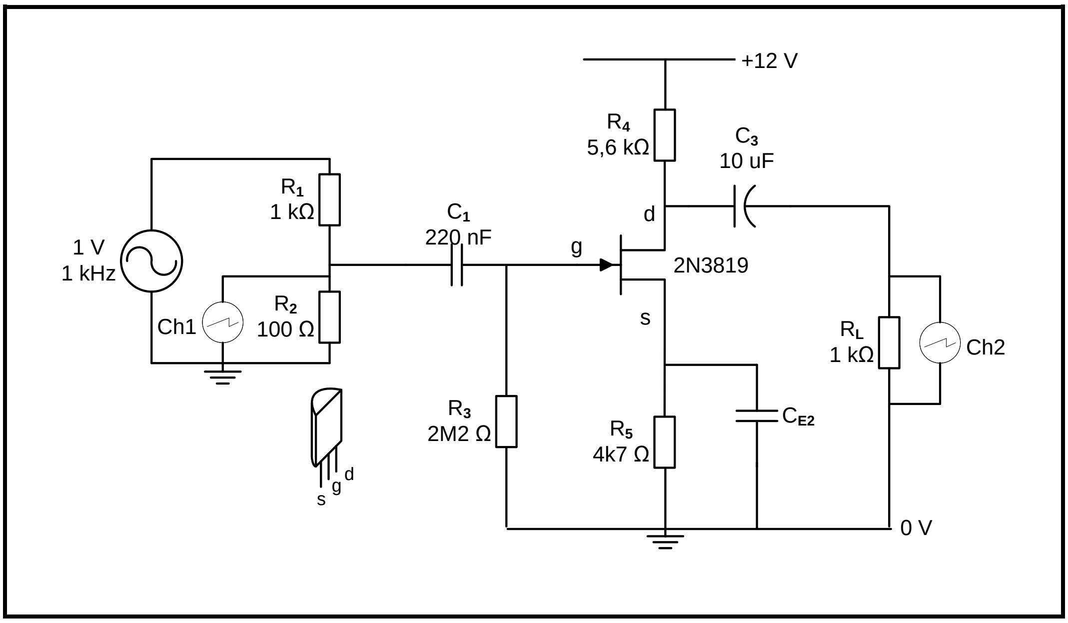
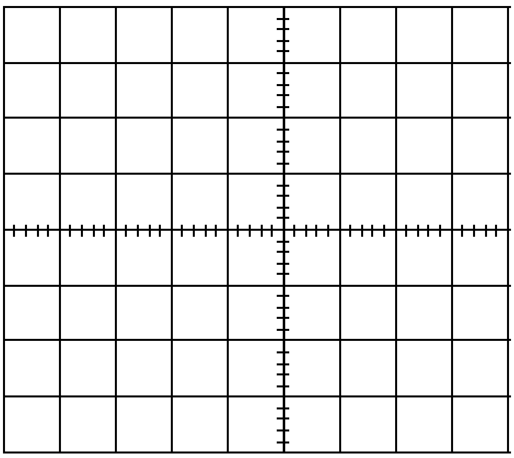


FIGURE 4.2: JFET AS AN AMPLIFIER

(b) Connect the function generator across R_1 and R_2 and adjust it to provide a 1 V peak sine wave.

(c) Connect channel 1 of the oscilloscope across R_2 and draw the waveform on the grid provided to scale.

(d) Connect channel 2 of the oscilloscope across the output of the amplifier and draw the waveform on the grid provided to scale.



V/Div:____________ (Ch 1)

V/Div:____________ (Ch 2)

T/Div: ____________

NOTE:
1 mark for each waveform correctly drawn and 1 mark for the oscilloscope settings.

(3)

(e) Use the oscilloscope settings and determine the peak value of the input and output signals.

$V_{IN(peak)}$ = ____________________________

$V_{OUT(peak)}$ = ____________________________ (2)

(f) Calculate the gain of the amplifier.

____

____

____

____

______________________________ (3)

(g) Compare the two waveforms and write a conclusion regarding the circuit.

____

____

____

____

____ (2)

Subtotal: Activity 2A (10)

FACET SHEET 2A: Using a JFET as an amplifier

	FACET 1	FACET 2	FACET 3	FACET 4	MAXIMUM POSSIBLE MARKS	LEARNER MARK
Prepare for the simulation	Identify components correctly (1)	Collect PSU/mini-trainer (1)	Collect instruments – oscilloscope (1)	Collect hand tools (1)	4/4 = 1	
Hand tools	Use side cutters correctly (1)	Use wire stripper correctly (1)	Use long-nose pliers correctly (1)		3/3 = 1	
Preparation for insertion of components into breadboard	Check the datasheet on the FET (1)	Set supply voltage correct at +12 V to +20 V (1)	Set input voltage correctly at 1 V from function generator (1)		3	
Correct connection on breadboard – nodes and polarity	Connect 6 nodes correctly (6/2 = 3)	Polarity of JFET correct (1)	Polarity of C_2 – correct (1)	Polarity of C_3 – correct (1)	6/2 = 3	
Connection of instruments	Correct setting of the oscilloscope (2)	Correct connection of the oscilloscope (2)	Correct reading of the oscilloscope (2)		6/2 = 3	
Circuit is working correctly	Output amplified (1)	Output phase vs input phase (1)			2	
Housekeeping	Cleaning the working area after the experiment (1)	Placing tools back to their places after work (1)			2/2 = 1	
Safety	Observing safety before being reminded (2)	Observing safety after being reminded (1)			2/2 = 1	
TOTAL					**15**	

Activity 2B: Using a Darlington pair as a current amplifier

4.2.4 REQUIRED RESOURCES:

TOOLS/INSTRUMENTS	MATERIALS
• Analogue/Digital trainer • Analogue/Digital oscilloscope • Function generator • Variable DC power supply • Side cutters • Wire stripper	• 2 x BC 109 NPN transistors • 1 x LED • 1 x 560 Ω resistor • 1 x 100 kΩ resistor • Connecting wires

4.2.5 PROCEDURE:

(a) Construct the circuit in FIGURE 4.3 on an experiment board.

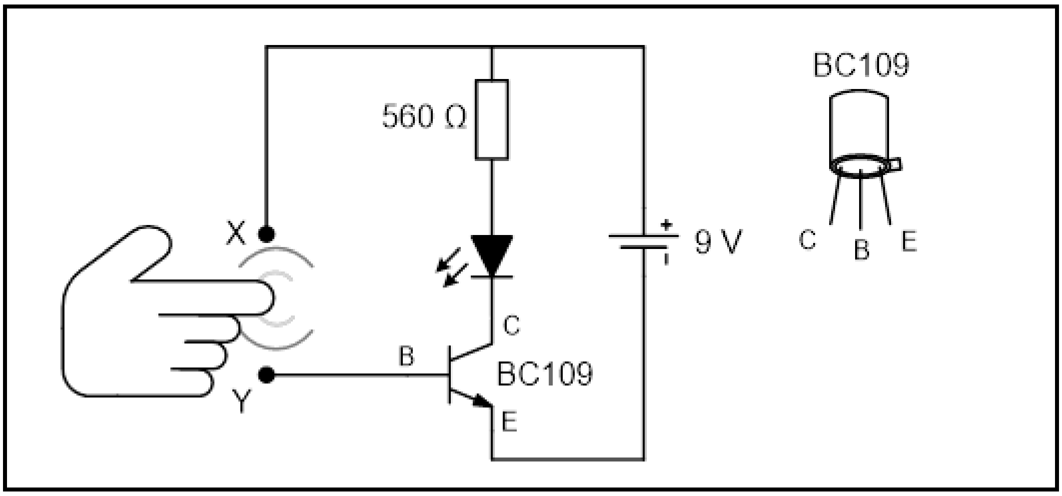


FIGURE 4.3 TRANSISTOR CIRCUIT

(b) Use your finger as a pathway for the current to connect points X and Y. Once your finger is connected, observe the brightness of the LED and record your findings.

____

____ (1)

(c) Replace the single transistor with two identical BC109 transistors, as indicated in FIGURE 4.4.

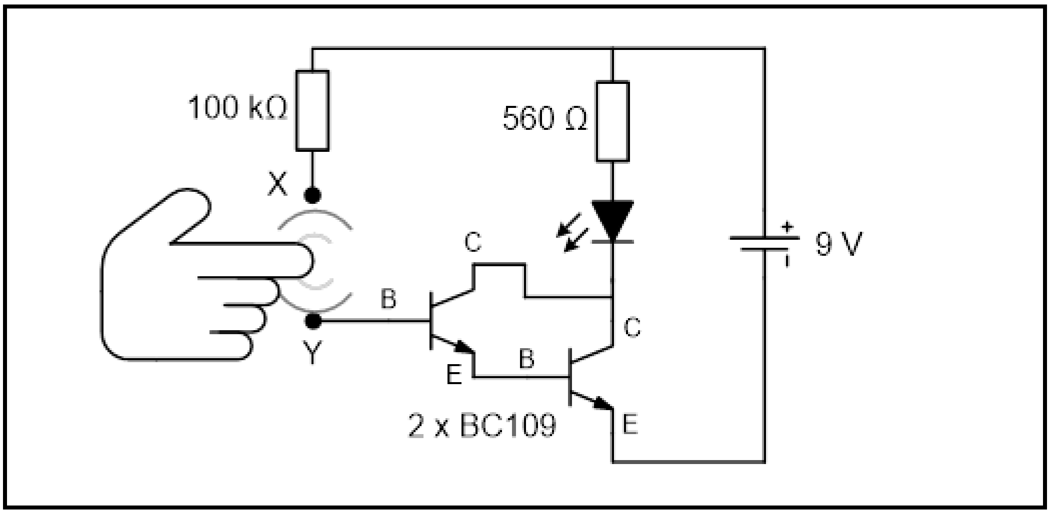


FIGURE 4.4: DARLINGTON PAIR

(d) Connect points X and Y with your finger. Write down your observation of the brightness of the LED

____

____

____ (1)

(e) Compare the brightness of the LED when one transistor was used and when two transistors were used. Motivate why this is observed.

____

____

____ (3)
(5)

FACET SHEET 2B: Using a Darlington pair as a current amplifier

	FACET 1	FACET 2	FACET 3	FACET 4	MAXIMUM MARKS	LEARNER MARK
Prepare for the simulation	Identify components correctly (1)	Collect PSU/ mini-trainer (1)	Collect instruments – multimeter (1)	Collect hand tools (1)	4/2 = 2	
Hand tools	Use side cutters correctly (1)	Use wire stripper correctly (1)			2/2 = 1	
Preparation for insertion of components into breadboard	Check the datasheet on the transistor and the Darlington pair (1)	Set supply voltage correct at +9 V (1)			2/2 = 1	
Correct connection on breadboard – nodes and polarity	Connect 6 nodes correctly (6/2 = 3)	Polarity of TR1 and TR2 correct (2)	Polarity of LED – correct (1)		6/2 = 3	
Circuit is working correctly	1 transistor Brightness of LED – dim (1)	2 transistors Brightness of LED – bright (1)			2/2 = 1	
Housekeeping	Cleaning the working area after the experiment (1)	Placing tools back to their places after work (1)			2/2 = 1	
Safety	Observing safety before being reminded (1)	Observing safety after being reminded (1)			2/2 = 1	
TOTAL					**10**	

Subtotal: Activity 2A ________ (10)
Subtotal: Facet sheet 2A ________ (15)
Subtotal: Activity 2B ________ (5)
Subtotal: Facet sheet 2B ________ (10)
TOTAL SIMULATION 2 ________ **[40]**

4.3 Simulation 3: Switching circuits – 741 bistable multivibrator and 555 astable multivibrator

Name of learner: ______________________________	**Mark** ____ / 40
Class: ___________ **Date Completed:** _______________	
Date Assessed: _______________	**Assessor Signature:** ______________
Date Moderated: _______________	**Moderator Signature:** ______________

Simulation 3A: 741 bistable multivibrator

4.3.1 PURPOSE:

- To study the 741 bistable multivibrator as a practical circuit
- To build a bistable multivibrator with the 741 op amp
- To compare the theory learned in class with the actual circuit

4.3.2 REQUIRED RESOURCES:

TOOLS/INSTRUMENTS	MATERIALS
• Experiment board • Voltmeter • Dual power supply 9V 0 –9V • Side cutters • Long-nose pliers • Wire stripper	• 1 x 741 op-amp DIP8 • 1 x 560 Ω resistor • 3 x 1 kΩ resistors • 2 x 470 Ω resistors • 1 x 10 µF capacitor • 1 x red LED • 1 x green LED • 2 x push button/tactile switches • Connecting wires

4.3.3 PROCEDURE:

(a) Build the circuit diagram in FIGURE 4.5 on your experiment board.

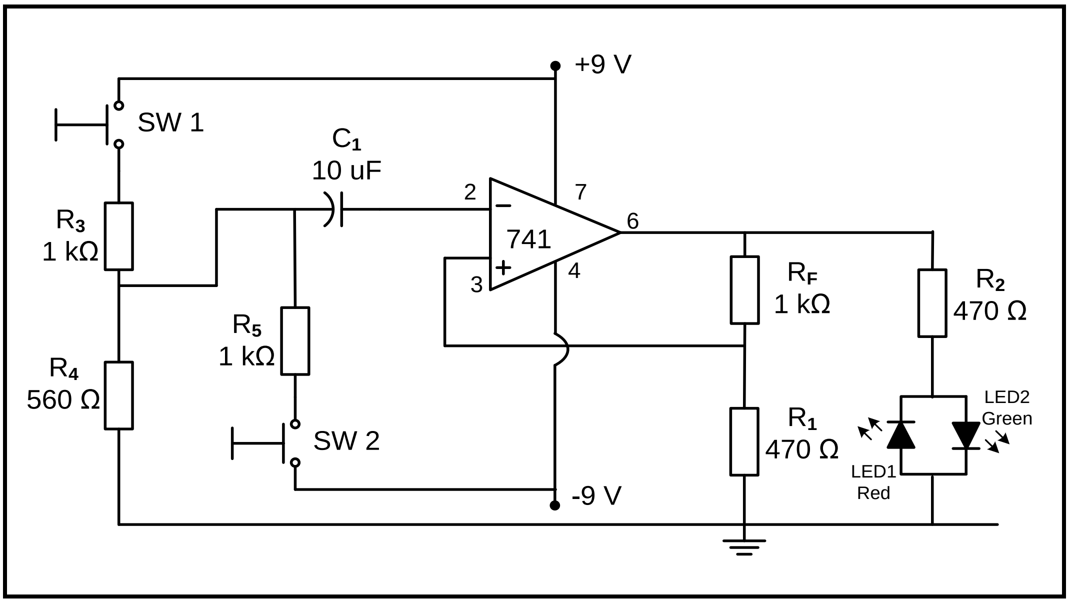


FIGURE 4.5: 741 BISTABLE MULTIVIBRATOR

(b) After the teacher has checked, switch on the circuit by pressing the switch (SW 1).
Connect channel 1 of the oscilloscope to pin 2 of the 741 IC.
Connect channel 2 of the oscilloscope to pin 6 of the 741 IC.
Set the T/div setting to 1s/div and answer the questions that follow.
Take note of the polarity of the input pulses, output signal and which LED is ON.

(c) Press switches S_1 and S_2 respectively. Write down the polarity of the input pulses and output when the switches are pressed.

	POLARITY OF INPUT PULSE	POLARITY OF OUTPUT SIGNAL
S_1		
S_2		

(4)

(d) Which LED is ON when S_1 is pressed? Motivate why.

____

(3)

(e) Explain why this circuit is known as a bistable multivibrator. Refer to the input signals, its polarity, the output signal and the time that the circuit remains in each state.

____

(5)

Subtotal: Activity 3A (12)

FACET SHEET 3A: 741 bistable multivibrator

	FACET 1	FACET 2	FACET 3	FACET 4	MAXIMUM POSSIBLE MARKS	LEARNER MARK
Prepare for the simulation	Identify components correctly (1)	Collect PSU/ mini-trainer (1)	Collect instruments – multimeter (1)	Collect hand tools (1)	4/2 = 2	
Hand tools	Use side cutters correctly (1)	Use long-nose pliers correctly (1)	Use wire stripper correctly (1)		3/3 = 1	
Preparation for insertion of components into breadboard	Check the pin out of the 741 IC (1)	Set supply voltage correctly at +9V 0V –9V (1)			2/2 = 1	
Correct connection on breadboard – nodes and polarity	Correct connection of 741 IC to supply (2)	Polarity and connection of switches correct (2)	Polarity of both LEDs – correct (2)		6	
Circuit is working correctly	S_1 is pressed – LED 1 (red) ON (1)	S_2 is pressed – LED 2 (green) ON (1)			2/2 = 1	
Housekeeping	Cleaning the working area after the experiment (1)	Placing tools back to their places after work (1)			2/2 = 1	
Safety	Observing safety before being reminded (1)	Observing safety after being reminded (1)			2/2 = 1	
				Subtotal: FACET 3A	**13**	

Simulation 3B: 555 IC astable multivibrator

4.3.4 PURPOSE:

Construct a simple circuit using the **555 IC** to build a clock pulse generator **(astable multivibrator)** and display output waveforms on an oscilloscope.

4.3.5 REQUIRED RESOURCES:

TOOLS/INSTRUMENTS	MATERIALS
• Analogue/Digital trainer • Analogue/Digital oscilloscope • Function generator • Variable DC power supply • Side cutters • Wire stripper	• 1 x 555 timer IC • 1 x 220 Ω resistor • 1 x LED • 1 x 10 nF capacitor • 1 x 10 KΩ resistor • 1 x 100 KΩ pre-set pot • 1 x 10 µF (electrolytic capacitor 16 V) • Connecting wires

4.3.6 PROCEDURE:

(a) Construct the circuit as in FIGURE 4.6 on the breadboard.
Connect channel 1 of the oscilloscope across C_1.
Connect channel 2 of the oscilloscope to pin 3 of the 555 IC.
Switch ON the circuit and observe.
Answer the questions that follow.

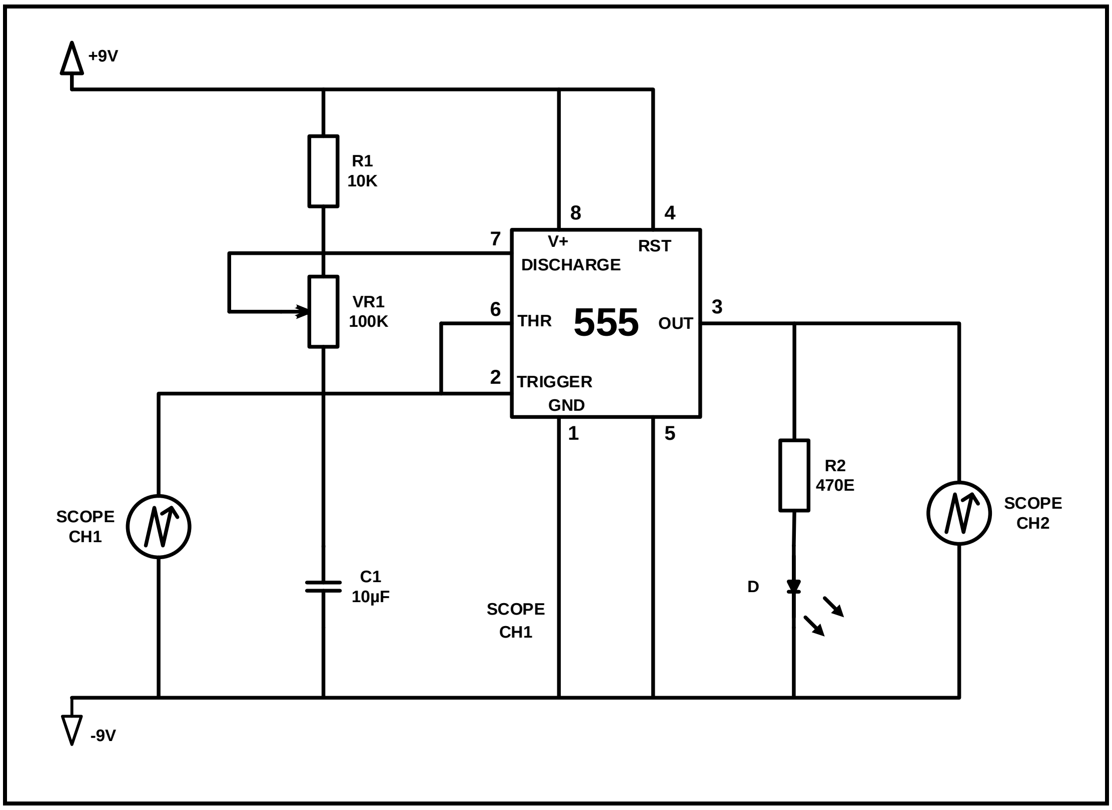
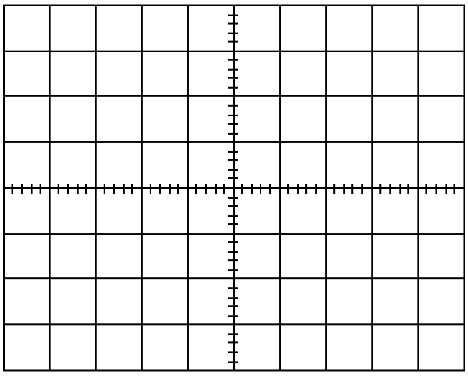


FIGURE 4.6: 555 IC ASTABLE MULTIVIBRATOR

(b) Draw the output waveform observed on the oscilloscope on the grid provided.



V/Div:___________ (Ch 1)

V/Div:___________ (Ch 2)

T/Div: ___________

NOTE:
1 mark for each waveform correctly drawn and 1 mark for the oscilloscope settings.

(3)

(c) List the components responsible for the frequency of the output.

____

____

________________________ (3)

SIMULATION 3B RUBRIC

1	2	3
Learner was able to construct a minimum part of the circuit correctly with assistance	Learner was able to construct a part of the circuit correctly without assistance	Learner was able to construct the whole circuit correctly without assistance
Learner failed to get the output wave on the oscilloscope	Learner was able to set the oscilloscope and managed to get the output wave after the assistance from the teacher	Learner was able to set the oscilloscope and managed to get the output wave without the assistance of the teacher
Learner did not do any housekeeping duties	Learner did housekeeping after being reminded	Learner did housekeeping without being reminded

(9)
(15)

Subtotal: Activity 3A	_____	(12)
Subtotal: Facet sheet 3A	_____	(13)
Subtotal: Activity 3B	_____	(15)
TOTAL SIMULATION 3	_____	**[40]**

This simulation is an alternative OPTION to do in the place of Simulation 3A.

Simulation 3C: 741 op amp as a non-inverting amplifier

4.3.7 PURPOSE:

To construct a simple circuit **using the 741 op amp to build a non-inverting amplifier** and display the input/output waveforms on an oscilloscope

Activity 3C: Construct a circuit using the 741 op amp

4.3.8 REQUIRED RESOURCES:

TOOLS/INSTRUMENTS	MATERIALS
• Analogue/Digital trainer • Analogue/Digital oscilloscope • Function generator • Dual power supply 9V 0 –9V • Side cutters • Wire stripper	• 1 x LM741 IC • 2 x 1 kΩ resistor • 2 x 10 kΩ resistor • 1 x 5 kΩ resistor • Connecting wires

4.3.9 PROCEDURE:

(a) Construct the circuit as in FIGURE 4.7 on the breadboard.
Set the function generator to give a sine wave output of 1 V peak at a frequency of 1 000 Hz (1 kHz).
Connect channel 1 of the oscilloscope to pin 3 of the 741 IC.
Connect channel 2 of the oscilloscope across RL (pin 6).

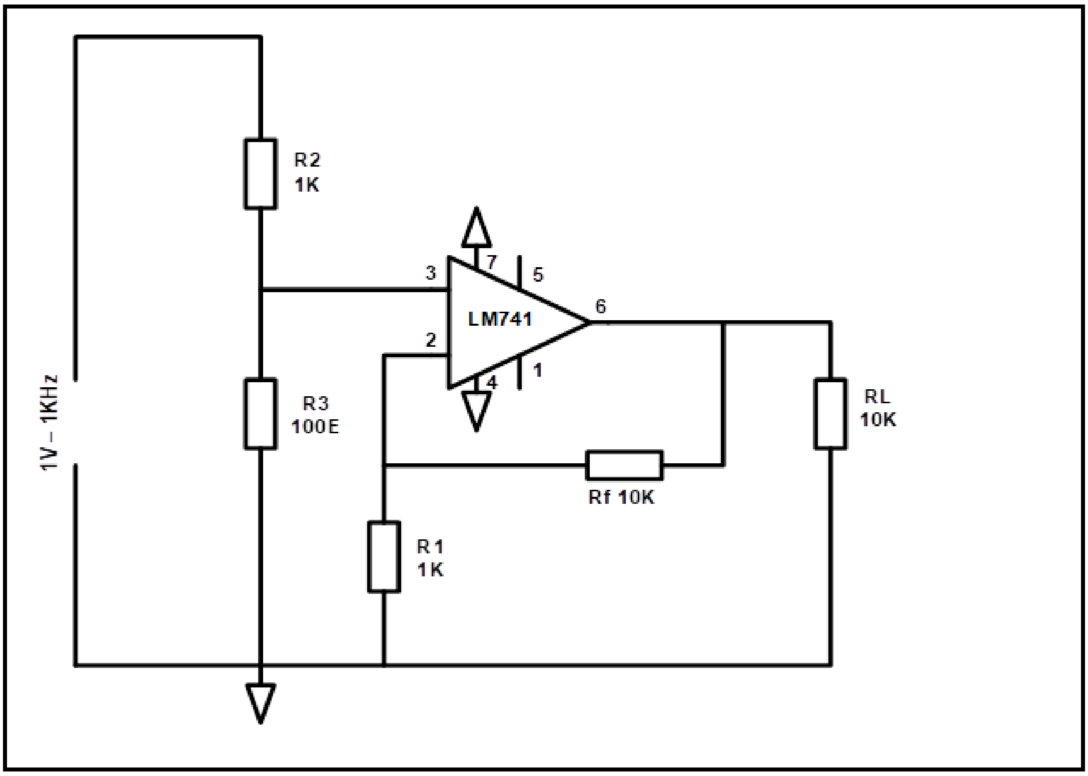
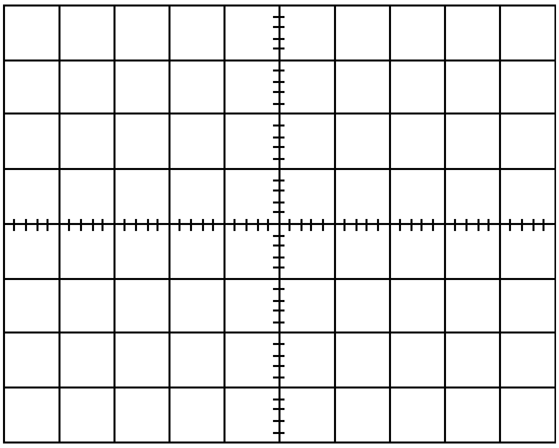


FIGURE 4.7: NON INVERTING AMPLIFIER

(b) Switch ON the power to the circuit and observe the input and output waveforms. Draw the input and output waveforms observed on the oscilloscope on the grid provided.



V/Div:____________ (Ch 1)

V/Div:____________ (Ch 2)

T/Div: ____________

NOTE:
1 mark for each waveform correctly drawn and 1 mark for the oscilloscope settings.

(3)

(c) Calculate the gain of the amplifier using the resistor values given.

(3)

(d) Measure the voltages across R_1, R_f and R_L:

V_{R1} = ____________
V_{Rf} = ____________
V_{RL} = ____________ (3)

(e) Replace Rf with a 5 kΩ resistor and measure the voltages across R_1, R_f and $R_{L:}$

V_{R1} = ____________
V_{Rf} = ____________
V_{RL} = ____________ (3)

(f) How did this change affect the output of the amplifier? Motivate your answer.

(3)
(15)

FACET SHEET 3C: 741 non-inverting op amp

	FACET 1	FACET 2	FACET 3	FACET 4	MAXIMUM POSSIBLE MARKS	LEARNER MARK
Prepare for the simulation	Identify the components correctly (1)	Collect PSU/ mini-trainer (1)	Collect instruments – multimeter (1)	Collect hand tools (1)	4/2 = 2	
Hand tools	Use side cutters correctly (1)	Use long-nose pliers correctly (1)	Use wire stripper correctly (1)		3/3 = 1	
Preparation for insertion of components into breadboard	Check the pinout of the 741 IC (1)	Set supply voltage correctly at +9V 0V –9V (1)			2/2 = 1	
Correct connection on breadboard – nodes and polarity	Correct connection of 741 IC to supply (2)	Measurement across R1, RF and RL (1)			3	
Circuit is working correctly	V_{out} is not inverted with RF = 10 kΩ (1)	V_{out} is not inverted with RF = 5 kΩ (1)			2/2 = 1	
Housekeeping	Cleaning the working area after the experiment (1)	Placing tools back to their places after work (1)			2/2 = 1	
Safety	Observing safety before being reminded (1)	Observing safety after being reminded (1)			2/2 = 1	
TOTAL					**10**	

Subtotal: Activity 3C ________ (15)
Subtotal: Facet sheet 3C ________ (10)
Subtotal: Activity 3B ________ (15)
TOTAL SIMULATION 3 ________ **[40]**

4.4 Simulation 4: 741 op-amp Schmidt trigger and summing amplifier circuit

Name of learner: ________________________________	**Mark** ____ 40
Class: ____________ **Date Completed:** ________________	
Date Assessed: ________________	**Assessor Signature:** _______________
Date Moderated: ________________	**Moderator Signature:** _______________

4.4.1 PURPOSE:

To construct a simple circuit using a 741 op amp to build a Schmidt trigger circuit and a summing amplifier circuit and display the output waveforms on an oscilloscope

Activity 4A: Construct a Schmidt trigger circuit using the 741 op amp

4.4.2 REQUIRED RESOURCES:

TOOLS/INSTRUMENTS	MATERIALS
• Analogue/Digital trainer • Analogue/Digital oscilloscope • Function generator • Variable DC power supply • Side cutters • Wire stripper	• 1 x LM741 op amp • 2 x 10 KΩ resistors • 3 x 1kΩ resistors • 1 x 2k2 Ω resistor (pre-set pot) • 1 x 100 kΩ resistor • 1 x 1M Ω • 1 x LED • Connecting wires

4.4.3 PROCEDURE:

(a) Construct the circuit as in FIGURE 4.8 on the breadboard.

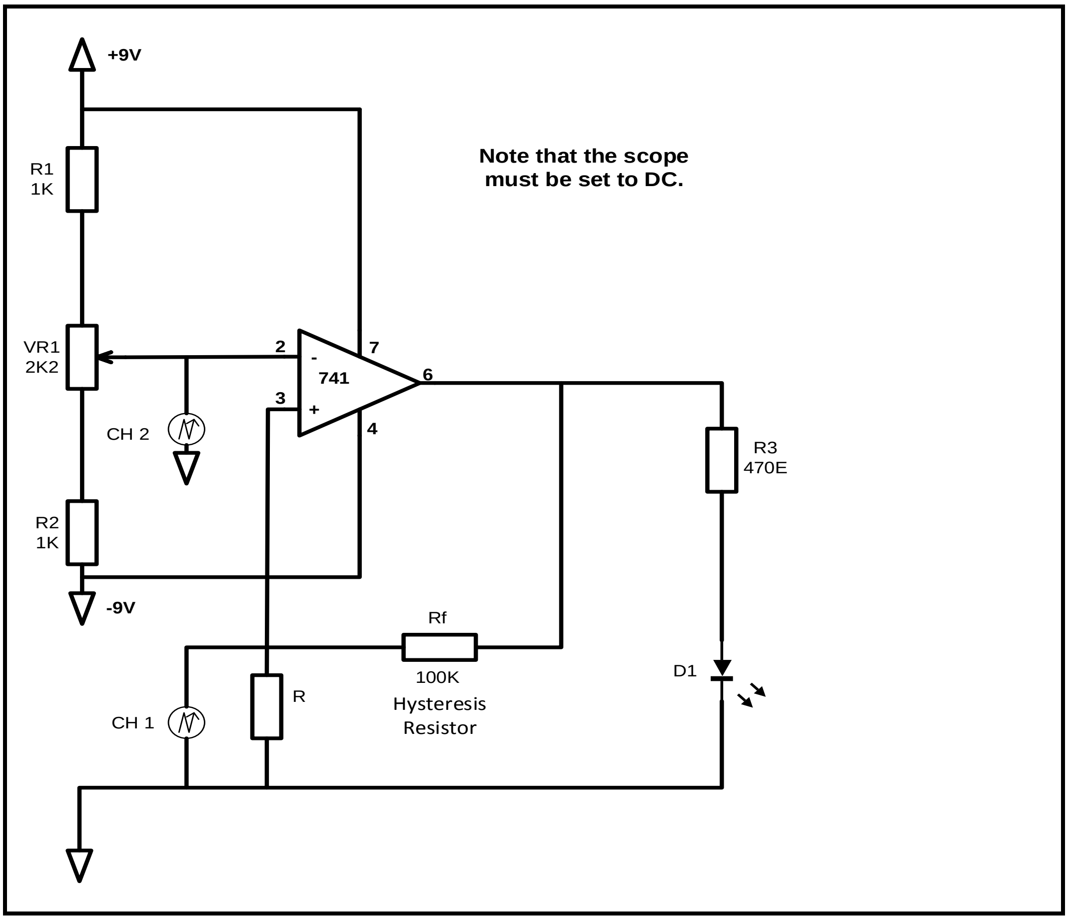


FIGURE 4.8

Learner was able to construct a minimum part of the circuit correctly without assistance	Learner was able to construct a part of the circuit correctly without assistance	Learner was able to construct the circuit correctly without assistance
1	**3**	**4**

(4)

(b) Adjust the potentiometer, while observing the output voltage.
The output switches to HIGH when Vin is ________V and to LOW when Vin is________V. The hysteresis is _______V. (3)

(c) Replace the 100 k resistor with a 10 k resistor. Adjust the input potentiometer slowly and observe the LED.

State what happens to the brightness of the LED when the hysteresis resistor is changed from 100 K to 10 K.

____ (1)

(d) Refer to (c) above.

The output now switches to HIGH when the input voltage is ______V and to LOW at ________V. The hysteresis is ________V. (3)

(e) Replace the hysteresis resistor with 1 MΩ resistor. The output now switches to HIGH at ________V and to LOW at ______ V. The hysteresis is ________V. (3)

(f) Remove the hysteresis resistor and adjust the potentiometer slowly. Write down your observation with regard to the LED

____

____ (1)

(g)

Learner did not do any housekeeping duties	Learner did housekeeping after being reminded	Learner did housekeeping without being reminded
1	**2**	**4**

(4)

4.4.4 CONCLUSION:

____

____

____

____ (2)

Subtotal: Activity 4A (21)

Activity 4B: Construct a summing amplifier circuit using the 741 op amp

4.4.5 REQUIRED RESOURCES:

TOOLS/INSTRUMENTS	MATERIALS
• Analogue/Digital trainer	• 6 x 1k Ω resistors
• Analogue/Digital oscilloscope	• 4 x 10 kΩ resistors
• Function generator	• 1 x 2k7 Ω resistor
• Variable DC power supply	• 3 x 2k2 Ω variable pots
• Side cutters	• 1 x LM 741 IC
• Wire stripper	• Connecting wires

4.4.6 PROCEDURE:

(a) Construct the circuit as in FIGURE 4.9 on the breadboard.

Learner was able to construct a minimum part of the circuit correctly without assistance	Learner was able to construct a part of the circuit correctly without assistance	Learner was able to construct the circuit correctly without assistance
2	3	5

(5)

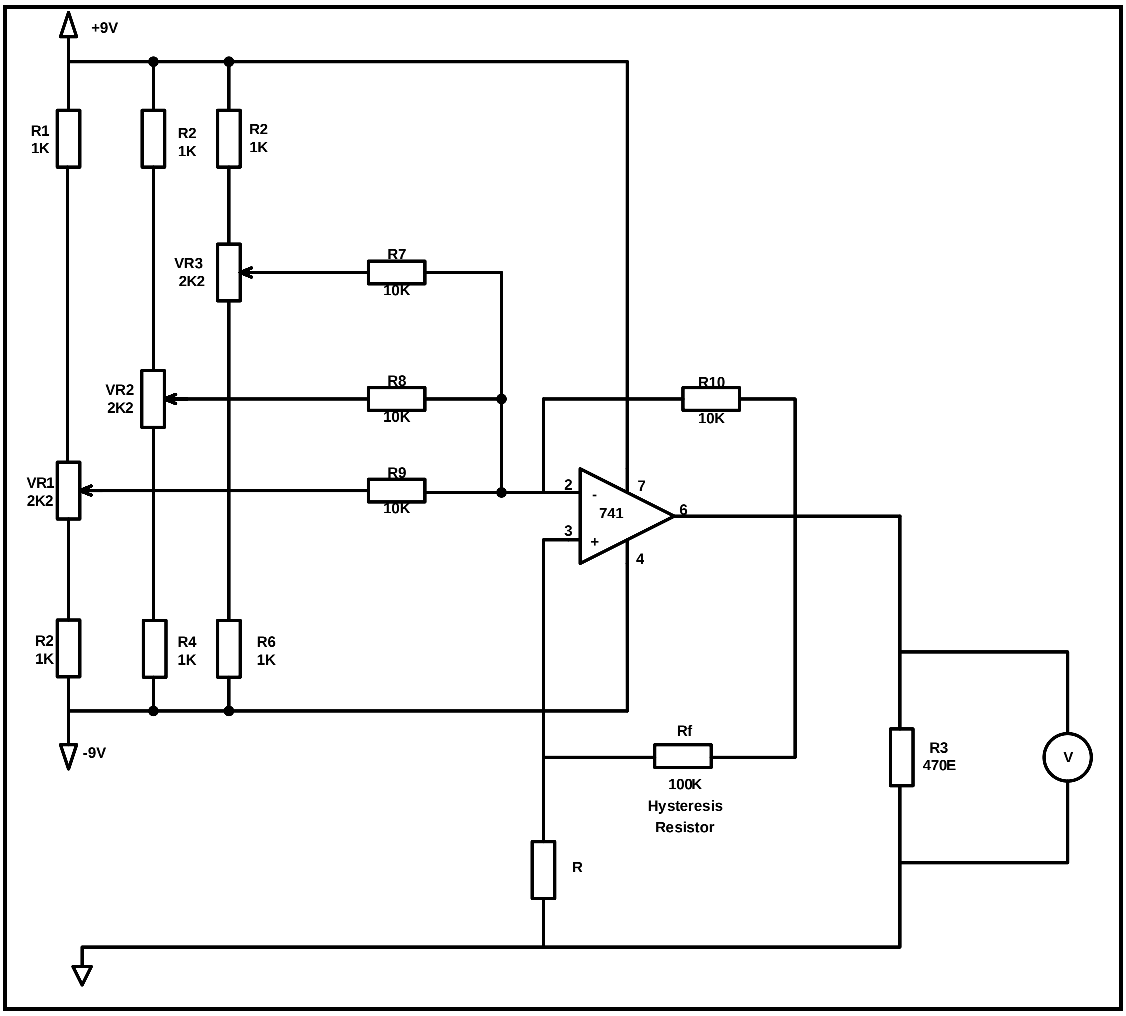


FIGURE 4.9

(b) Use the 2k2 pots to set V1, V2 and V3 to the voltages as indicated in the table below. Measure the output values and populate the table below.

V_1	+	V_2	+	V_3	=	V_{out}
3	+	2.5	+	1.75	=	
1.5	+	-4	+	2.2	=	
5	+	-4.5	+	1	=	
-4	+	1.5	+	2.5	=	
-1.5	+	-2.25	+	-3.25	=	

(5)

4.4.7 CONCLUSION:

____

____

____

____

____ (5)

Learner did not do any housekeeping duties	Learner did housekeeping after being reminded	Learner did housekeeping without being reminded
1	**2**	**4**

(4)

Subtotal: Activity 4B (19)

Subtotal: Activity 4A ________ (21)
Subtotal: Activity 4B ________ (19)
TOTAL SIMULATION 4 ________ **[40]**

4.5 Simulation 5: Colpitts oscillator

Name of learner: ______________________________	**Mark**	____ 40
Class: ___________	**Date Completed:** _______________	
Date Assessed: _______________	**Assessor Signature:** _______________	
Date Moderated: _______________	**Moderator Signature:** _______________	

4.5.1 PURPOSE:

Construction of the Colpitts oscillator circuit using discreet components and displaying the input/output waveforms on an oscilloscope

4.5.2 RESOURCES:

TOOLS/INSTRUMENTS	MATERIALS	ALTERNATIVE VALUES
• Analogue/Digital trainer • Analogue/Digital oscilloscope • Function generator • Multimeter • Variable DC power supply • Side cutters • Wire stripper • Long-nose pliers • Connecting wire	• 1 x 2N22905 transistor • 1 x 470 KΩ resistor • 1 x 680 Ω resistor • 1 x 2,2 KΩ resistor • 2 x 0,1 µF capacitor • 1 x 47 µF capacitor • 1 x 0,1 µF capacitor • 2 x 47 nF capacitor • 1 x 0,47 µF capacitor • 1 x 10 mH inductor • 12 V DC supply	• BC 182 • 150 KΩ • 2 KΩ • 100 µF • 470 pF • 100 pF • 200 pF • 200 pF • Interstage transformer • 9 V DC

4.5.3 PROCEDURE:

(a) Build the circuit in FIGURE 4.10 on the breadboard.

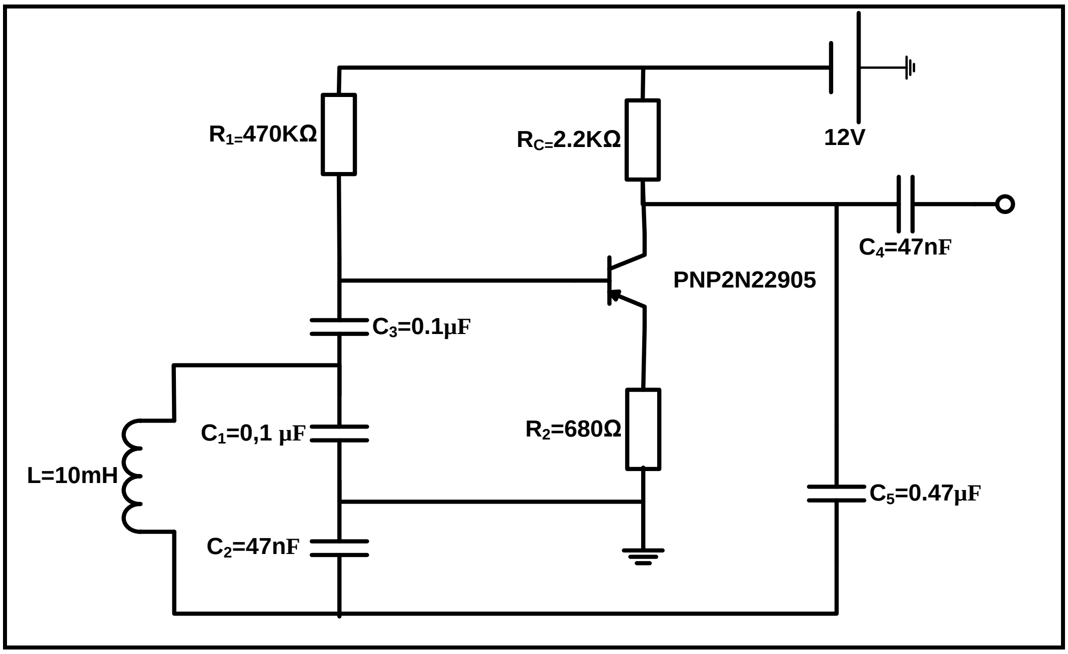
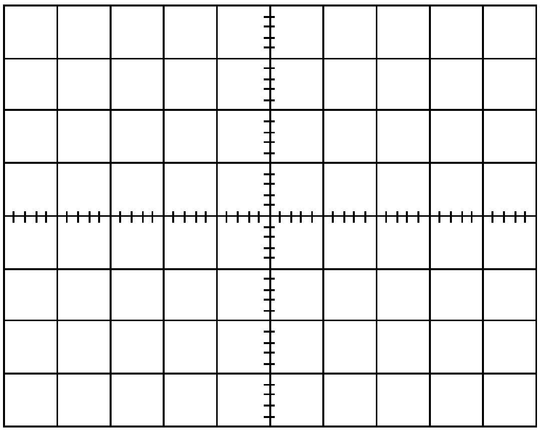


FIGURE 4.10

(b) Switch ON the circuit. Draw the output of the oscillator on the grid provided.



V/Div:____________ (Ch 1)

V/Div:____________ (Ch 2)

T/Div: ____________

NOTE:
1 mark for each waveform correctly drawn and 1 mark for the oscilloscope settings. (3)

(c) Measure and record the following DC voltages:

V_{R1} = __________________________ (2)

V_{R2} = __________________________ (2)

V_{BE} = __________________________ (2)

V_{CE} = __________________________ (2)

V_{RC} = __________________________ (2)

(d) Connect the oscilloscope, measure and record the resonant frequency:

____________________kHz (2)

(e) Calculate the theoretical resonant frequency.

____

____

____

____

______________________________ (3)

(f) Replace capacitors C_1 and C_2 with C_1 = 470 pF and C_2 = 1 000 pF respectively. Measure and record the oscillations frequency:

____ (2)

(g) Calculate the oscillation frequency:

____

____

____

____

____ (3)

(h) State the function of R_C in the circuit:

____

____

____

____ (2)

FACET SHEET 5B: Colpitts oscillator

	FACET 1	FACET 2	FACET 3	FACET 4	MAXIMUM POSSIBLE MARKS	LEARNER MARK
Prepare for the simulation	Identify components correctly (1)	Collect PSU/mini-trainer (1)	Collect instruments – multimeter (1)	Collect hand tools (1)	4/2 = 2	
Hand tools	Use side cutters correctly (1)	Use long-nose pliers correctly (1)	Use wire stripper correctly (1)		3/3 = 1	
Preparation for insertion of components into breadboard	Refer to datasheet for pinout (1)	Set supply voltage correctly at 12 V (1)			2	
Correct connection on breadboard – nodes and polarity	Correct connection transistor (2)	Correct polarity of supply (1)	Voltage measurement across components (3)		6	
Circuit is working correctly	Oscillation frequency at output sine wave (2)				2	
Housekeeping	Cleaning the working area after the experiment (1)	Placing tools back to their places after work (1)			2/2 = 1	
Safety	Observing safety before being reminded (1)	Observing safety after being reminded (1)			2/2 = 1	
TOTAL					**15**	

Subtotal: Activity 5A ________ (25)
Subtotal: Facet sheet 5B ________ (15)
TOTAL SIMULATION 5 ________ **[40]**

5. SECTION B – DESIGN AND MAKE

Design and Make Project

Time: January to August 2020

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):
  - No less than 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 on the next page must be used to ensure that all the required tasks for the PAT have been completed.

PAT CHECKLIST

NOTE: The learner MUST complete this checklist for the teacher BEFORE marking of that section takes place.

NO.	DESCRIPTION	TICK (☑) NO	TICK (☑) 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	☐	☐
6.	Evidence of prototyping printed and pasted into the file	☐	☐
7.	Learner's own Veroboard/PCB planning/design printed and included in file	☐	☐
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 placed 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 is 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 your project and add it after this page.

5.1.2 Project: Description of operation

Use the space below to provide an overview of how the project functions. Use your own words and do some research of your own.

5.1.3 Component list

Draw up a list of components you will need from the circuit diagram.

LABEL	DESCRIPTION AND VALUE	QUANTITY

5.1.4 Tools/Instrument list

Draw up a list of tools you will need to complete the PAT circuitry. You may add to the list as you proceed through the PAT.

DESCRIPTION	PURPOSE/USE

5.1.5 Evidence of prototyping

Take photographs of the working prototype on the breadboard using a digital camera or cellphone and insert here. Add your name on the photograph.

Add the pictures after this page.

5.1.6 PCB design

Design a circuit board layout for the circuit you are going to build.

Print it out and attach after this page.

5.2 Assessment of the Design and Make phase: Part 1

NO.	FACET DESCRIPTION	Mark	Achieved = ✓ Not achieved = ✗
	Circuit Diagram		
1.	The circuit diagram was drawn using EGD equipment.	1	
2.	The circuit diagram was drawn using CAD/any electronic design software.	1	
3.	The circuit diagram was drawn using correct symbols.	1	
4.	The circuit diagram has all labels – R1, C1, Tr1, etc.	1	
5.	The circuit diagram has all component values –100 Ω, 220 μF, etc.	1	
6.	The circuit diagram has a name/title.	1	
7.	The circuit diagram has a frame and title block. (EGD approach)	1	
	Component List		
8.	Labels correlate with circuit diagram.	1	
9.	Description and values correlate with circuit diagram.	1	
10.	Quantities are correct.	1	
	Description of Operation		
11.	Basic function of the circuit is described correctly.	1	
12.	All subcircuits in the circuit diagram and component list are included in the description.	1	
13.	Purposes of subcircuits in the circuit diagram are described correctly.	1	
14.	Learner used own interpretation and did not copy from another source verbatim.	1	
15.	Sources are acknowledged.	1	
	Tools/Instrument List		
16.	The tools/instrument list has been completed.	1	
17.	The tools/instruments listed all have a purpose for being used.	1	
	Evidence of Prototyping on Breadboard		
18.	Unique, original photos of the prototyping are included.	1	
19.	Unique, original photos include the learner name.	1	
20.	Photos are clear and in focus: All components are clearly identifiable.	1	
21.	Prototype is operational. No photo, no mark.	2	
	PCB Design		
22.	Printed circuit board design is included in the PAT file.	1	
23.	PCB design is made using a CAD approach.	3	
24.	Component overlay showing placement is included.	1	
25.	Components are labelled the same as in the circuit diagram.	1	
26.	The design is original and does not match any other learner's design.	1	
27.	Board layout (tracks/current flow) is functional and matches the original circuit diagram.	1	

NO.	FACET DESCRIPTION	Mark	Achieved = ✓ Not achieved = ✗
	Circuit Board Manufacturing		
28.	Circuit board is etched neatly according to the PCB design.	5	
29.	The learner's name is etched onto the circuit design.	1	
30.	The PCB is tinned neatly.	1	
31.	The soldered PCB, solder side, is covered with a clear protective coating. (Plastic 70/clear lacquer)	1	
32.	Holes are drilled neatly and are aligned in the middle of the pads on the PCB.	1	
33.	Mounting holes of the PCB are drilled symmetrically.	1	
34.	All burrs are removed.	1	
35.	The PCB is cut neatly/squarely and edges are filed neatly.	1	
36.	Axial and radial components are placed neatly and flush with the board.	1	
37.	Component orientation are aligned between similar components (e.g. the gold band of all resistors are placed on the same side).	1	
38.	Soldered components – leads are cut off, flush and neat on the solder side.	2	
39.	More than 60% of the solder joints are shiny (not dry joints).	2	
40.	Wire insulation is stripped to the correct length (no extra copper showing).	2	
41.	Wiring is long enough to allow for dismantling and inspection.	1	
42.	Wiring is wrapped neatly.	1	
43.	A power switch is included and fitted to the enclosure.	2	
44.	A fuse/protection is included and fitted correctly where applicable.	2	
45.	Wiring entering/exiting the enclosure is provided with a grommet/applicable fittings/sockets where applicable.	2	
46.	Batteries are mounted using a battery housing/mounting bracket and battery clip (NO double-sided tape).	1	
47.	The project has a pilot light/LED installed in the enclosure showing when the circuit is operational. (Switch is on – must go out when fuse is blown.)	1	
48.	The project is fully operational and commissioned/installed in the enclosure.	10	

TOTAL (PART 1 = 70 marks)	

NOTE: In projects where facets are not applicable, 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, Perspex/Plexiglas, etc. You must, however, construct/assemble these parts.
Injection-molded 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.

[20]

5.4 Assessment of the Design and Make phase: Part 2

NO.	FACET DESCRIPTION	Mark	Achieved = 1 Not achieved = ✗
	Enclosure Desig		
1.	Enclosure design is included in first-angle orthographic projection.	1	
2.	Drawn design includes a title box and page border.	1	
3.	Isometric drawing included additionally.	1	
4.	Dimensions are included.	1	
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	
	Subtotal (7 marks max.)		
	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.	1	
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).	1	
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	3	
12.	Holes/Cut-outs in the enclosure are made with the appropriate tools.	2	
13.	Specification plate with the learner's name, operating voltage, fuse rating and additional information on the project.	1	
14.	Enclosure is neatly prepped, 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.)	1	
	Subtotal (13 marks max.)		

TOTAL (PART 2 = 20 marks)	

6. PROJECTS

6.1 PRACTICAL PROJECT 1: 5 Watt mini-amplifier (portable speaker)

This micro-sized high quality amplifier was originally designed to replace amplifiers in car radios where the original ICs are no longer available. This does not limit the use to that application. Use your imagination: There are a million other uses. Always use an adequate heat sink.

THE CIRCUIT

The TDA 2002 or TDA 2003 is used in a very straight forward audio amplifier configuration and only a few precautions must be taken when using it.

Firstly, because of the very high input impedance, **the input connections must be screened cables** and kept as short as possible, to eliminate pickup of stray radio frequency and other interference. Secondly, the fact that the PCB is so small limits the amount of decoupling capacitance (C5) that can be provided on the board. If the supply does not have at least a few hundred microfarads smoothing, then the amplifier could go into oscillation, and that means you have to place, e.g., an 1 000 µF 16 V capacitor over the supply voltage

Tips on construction:

No problems should be experienced when assembling this amplifier. Just check for the polarity of the electrolytic capacitors and make sure that the soldering is done properly. Care must also be taken when connecting the power to the PCB.

NOTE: IF THE POLARITY IS REVERSED, THE IC WILL BE DESTROYED.

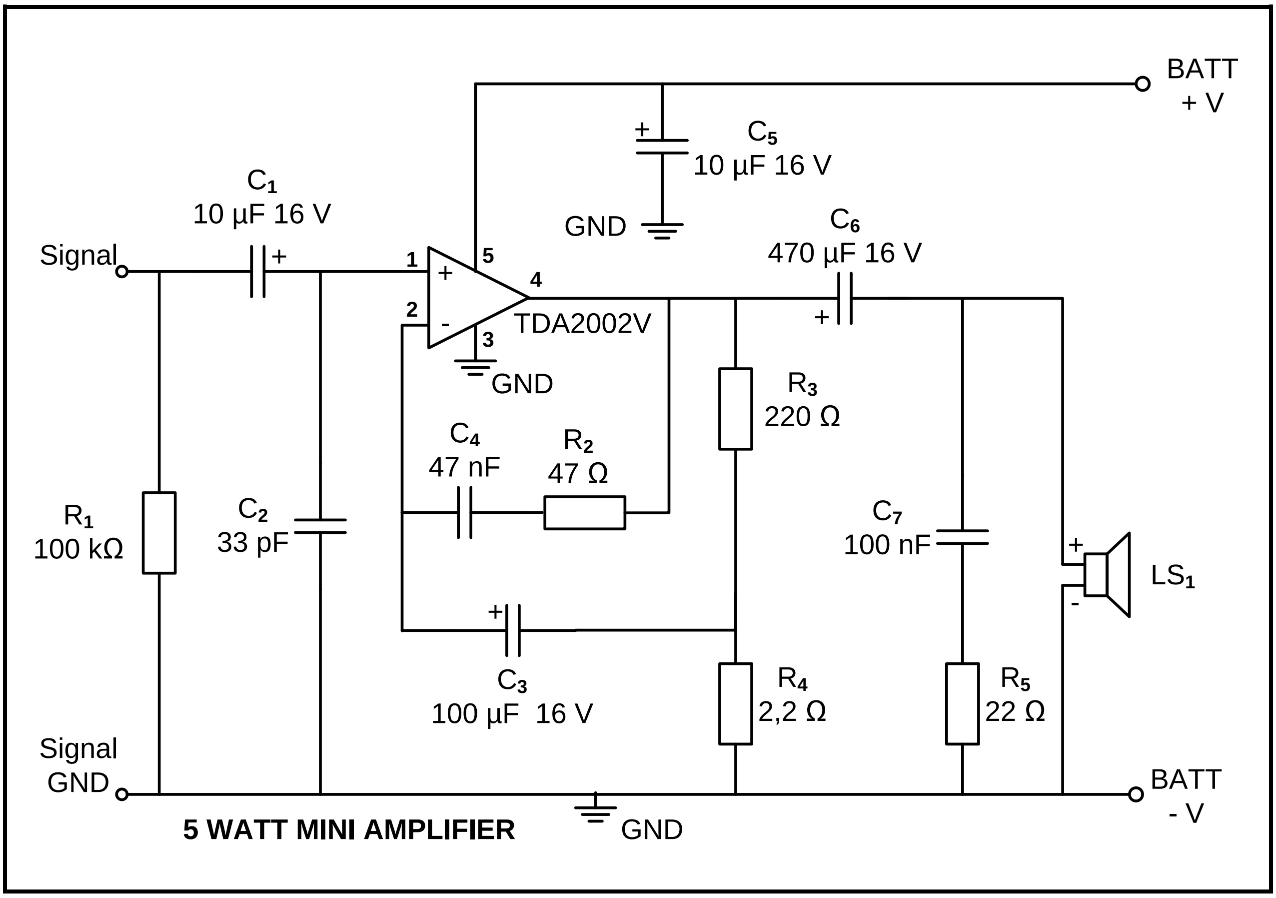
COMPONENT LIST:

R_1	Can be replaced with a 100K preset if required	
R_1	100K 1/4W resistor Brown Black Yellow Gold	1
R_2	47 OHM 1/4W resistor Yellow Violet Black Gold	1
R_3	220 OHM 1/4W resistor Red Red Brown Gold	1
R_4	2,2 OHM 1/4W resistor Red Red Gold	1
R_5	22 OHM 1/4W resistor Red Red Black Gold	1
C_1	10 uF 16V electrolytic radial capacitor	1
C_2	33 pF non-polarised ceramic capacitor	1
C_3	100 uF 16 V electrolytic radial capacitor	1
C_4	47 nF non-polarised capacitor (473; 0,047 uF)	1
C_5	10 uF 16 V electrolytic radial capacitor	1
C_6	470 uF 16 V electrolytic radial capacitor	1
C_7	100 nF non-polarised capacitor (104; 0,1 uF)	1
IC_1	TDA 2002 OR TDA 2003 Sound IC	1
PP_3	9 V Battery Clip	1
	10 cm mono-screened cable for Signal IN Connection	1
PCB	EFK # 1002	1

RESOURCES:

TOOLS AND EQUIPMENT
• Oscilloscope (analogue/digital) • Analogue/Digital trainer with dual power supply • Multimeter • Side cutters • Wire stripper • Soldering iron • Helping hands • PCB etching tank or similar • Solder sucker

CIRCUIT DIAGRAM:



OR

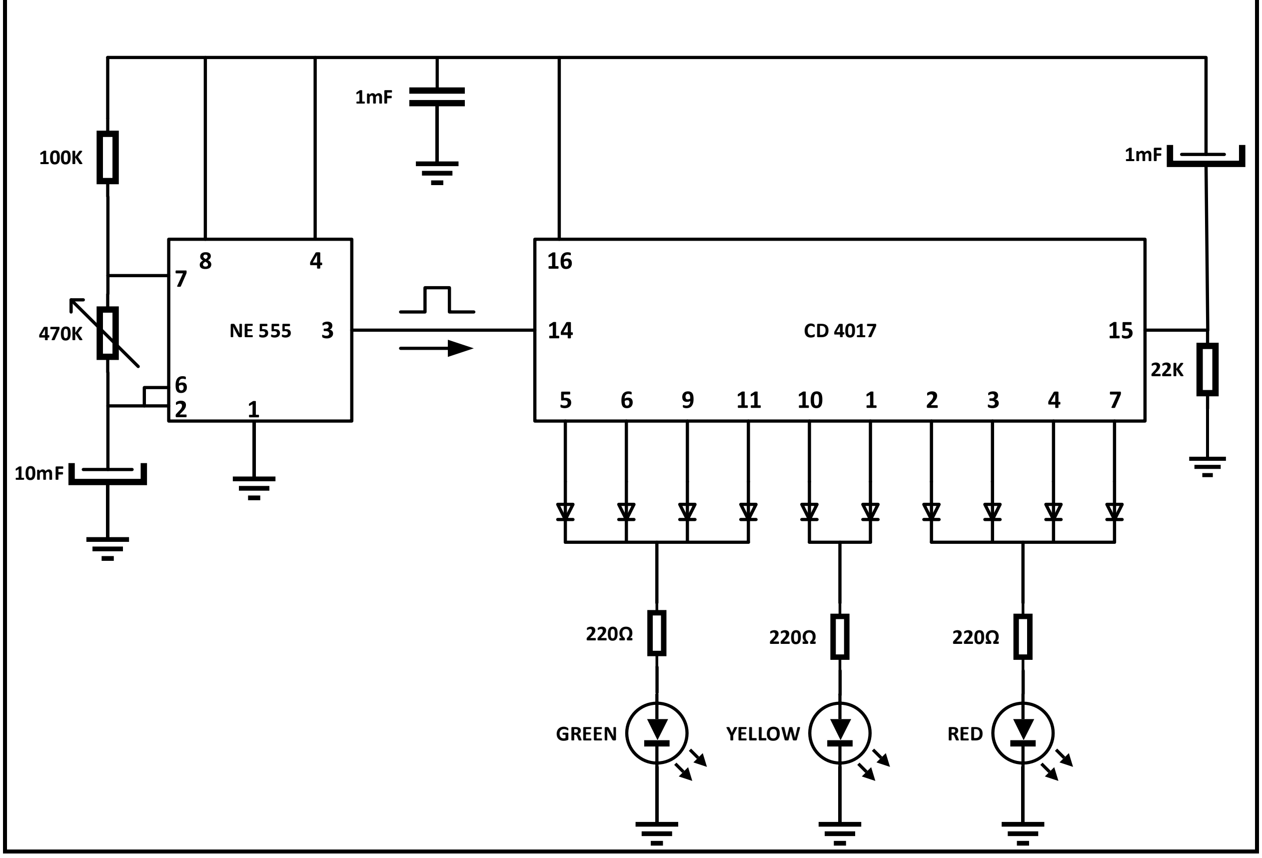
6.2 PRACTICAL PROJECT 2 (ELECTRONICS): Traffic light

RESOURCES:

TOOLS	MATERIALS
• Oscilloscope (analogue/digital) • Analog/Digital trainer with dual power supply • Electronics multimeter • Side cutters • Wire stripper • Soldering Iron • Helping hands • PCB etching tank or similar • Solder sucker	• 100 k Ω resistor • 220 Ω resistor x 3 • 22 k Ω resistor x1 • LED green x1 • LED yellow x 1 • LED red x 1 • 1 µ F capacitor x 2 • 10 µF capacitor x 1 • 470 k Ω variable resistor x 1 • IC NE555 • IC CD 4017 • 1N4007 Diode x6 • PCB 150 x 100 mm • Solder • PCB etching chemicals

CIRCUIT DIAGRAM:

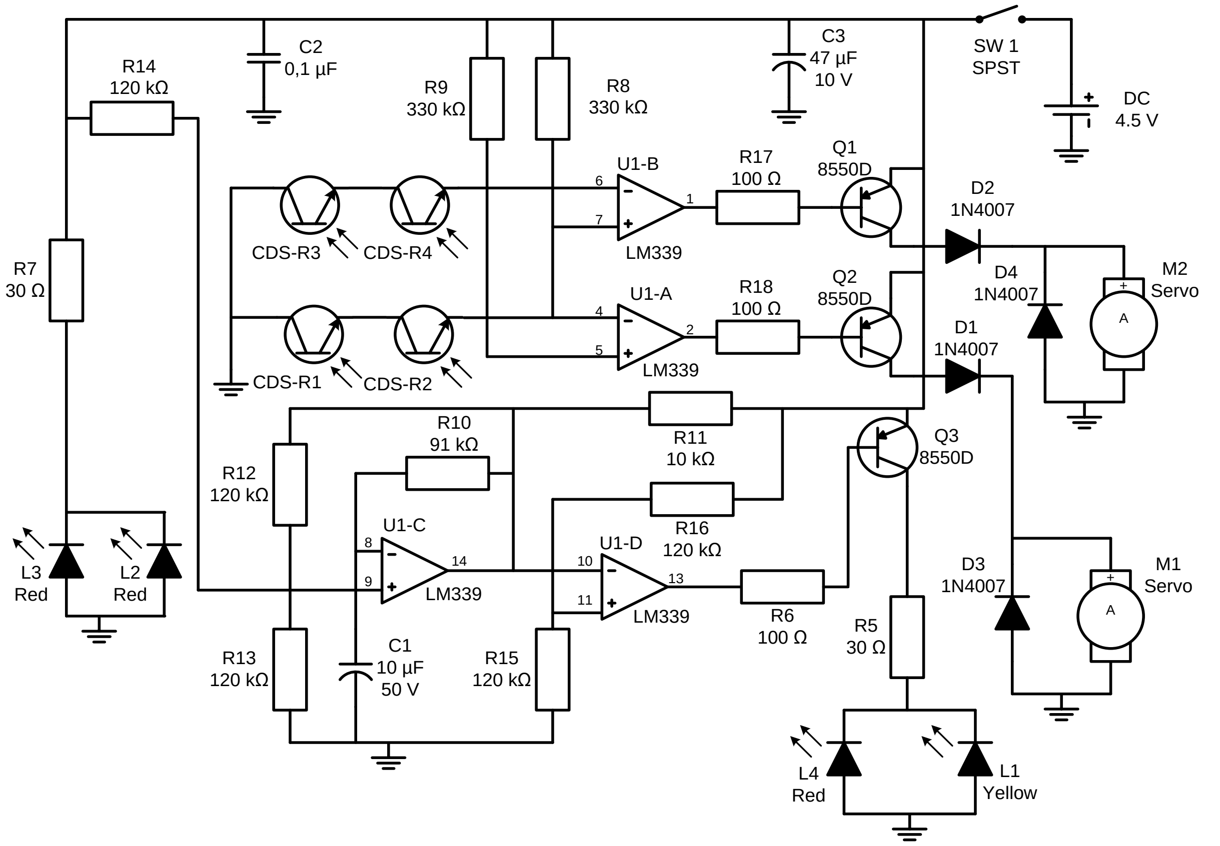
TRAFFIC LIGHT CIRCUIT



OR

6.3 PRACTICAL PROJECT 3: Line-following buggy

The line-following buggy will follow a black line drawn on white paper by TWO photo interrupters. Create different routes with black electric tape or a black marker for your line-tracking robot. The buggy operates using an IR sensor. The IR diode transmits a signal when a black line is encountered. The signal is fed to the IC chip that stops or starts each motor, alternatively switching ON and OFF motor 1 and 2 to alter the buggy's direction.



RESOURCES:

NO.	POSITION	ITEM	DESCRIPTION	QTY
1.	R5, R7	Resistor	30 Ω 1/8 W 5%	2
2.	R6, 17, 18	Resistor	100 Ω 1/8 W 5%	3
3.	R8, R9	Resistor	330 kΩ 1/8 W 5%	2
4.	R10	Resistor	91 kΩ 1/4 W 5%	1
5.	R11	Resistor	10 kΩ 1/4 W 5%	1
6.	R12, 13, 14, 15, 16	Resistor	120 kΩ 1/4 W 5%	5
7.	R1/CDS, R2/CDS, R3/CDS, R4/CDS	Photo sensor	WJ5800D	4
8.	C3	Electrolytic capacitor	47 µF/16 V	1
9.	C1	Electrolytic capacitor	10 µF/16 V	1
10.	C2	Ceramic capacitor	104/50 V	1
11.	D1, 2, 3, 4	Diode	1N4007 ¼ W	4
12.	S1	Slide switch	SK-12f1406(1p2t) H = 8 mm	1
13.	BH-3V	Battery holder	AA x 2: 58 x 34 mm	1
14.	L1	LED	5 mm yellow diffuse LED	1
15.	L2, 3, 4,	LED	5 mm red diffuse LED	3
16.	Q1, 2, 3	Transistor	S8550D TO-92	3
17.	U1	IC	LM339N	1
18.	Gear box	Gear box		1
19.	Metal wheel	Metal wheel	4 direction	2
20.	Plastic wheel	Plastic wheel	R = 37 mm	1
21.	M1, M2	Servo motor	Servo motor	2

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.