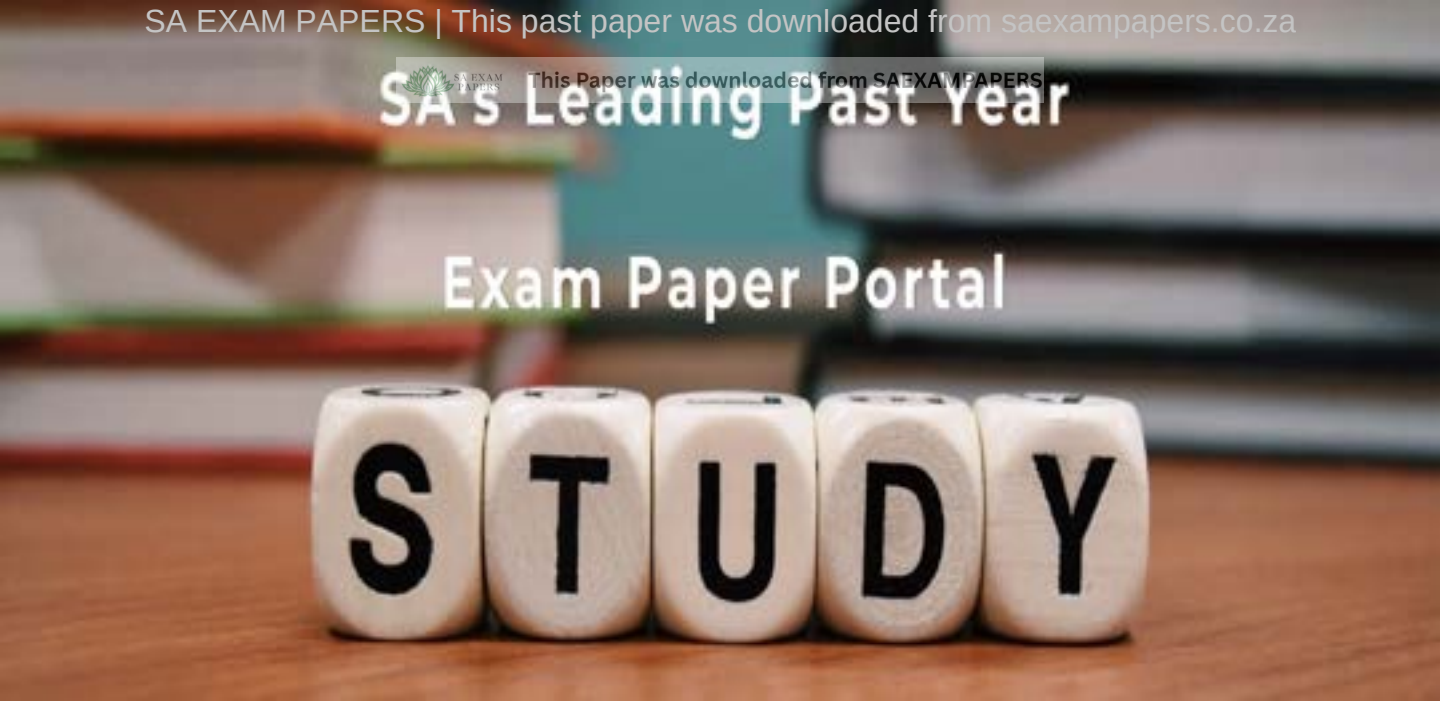


GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

JUNE EXAMINATION
GRADE 12

2026

NAME:	

DATE:	**2**	**0**	**2**	**6**	**–**	M	M	**–**	D	D

SCHOOL:	

SUBJECT:	**ELECTRICAL TECHNOLOGY: ELECTRONICS**

ANSWER ALL THE QUESTIONS IN THE QUESTION PAPER.

MARKER					INT. MODERATOR				DIST. MODERATOR				PROV. MODERATOR			
Question	Marks			Marker's code & initials	Marks			IM's code & initials	Marks			DM's code & initials	Marks			PM's code & initials
1																
2																
3																
4																
5																
TOTAL																

TIME: 3 hours

MARKS: 200

34 pages + a 1-page formula sheet

INSTRUCTIONS AND INFORMATION

1. This question paper consists of FIVE questions. Answer ALL the questions in the spaces provided.
2. Use the mark allocation as a guide to the length of your answers.
3. Sketches and diagrams must be large, neat and FULLY LABELLED.
4. Show ALL calculations and round-off answers correctly to TWO decimal places.
5. You may use a non-programmable calculator.
6. A FORMULAE SHEET is attached at the end of this question paper.
7. Calculations must include:
   - 7.1 Formulae and manipulation where needed
   - 7.2 Correct replacement values
   - 7.3 Correct answer and relevant units where applicable
8. No pages may be torn from this question paper.
9. Candidates may not retain a question paper or remove it from the examination room. Question papers must be returned to the invigilator at the end of the examination session.
10. Answers must be written in black/blue ink as distinctly as possible. Do NOT write in the margins.
11. Indicate the questions you have answered by drawing a circle around the relevant numbers on the front cover of the question paper where marks are to be recorded.
12. Draw a neat line through any work/rough work that must NOT be marked.
13. In the event that you use the additional space provided:
    - 13.1 Write down the number of the question.
    - 13.2 Leave a line and rule off after your answer.
14. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions.
Choose the correct answer and write only the letter (A – D) for each of the corresponding questions (1.1 to 1.15) in the blocks provided.

1.1 The purpose of the Occupational Health and Safety Act is to provide for the health and safety of:

A Machines used by persons at work
B Persons with regard to the use of industrial equipment and machines
C The Advisory Council for Occupational Health and Safety and related matters
D All of the above (1)

1.2 Which of the following is considered an unsafe act?

A Poor ventilation
B Excessive noise
C Spilling liquids on the floor without cleaning it up
D Uneven floor surfaces (1)

1.3 Which of the following is an example of an incident that must be reported to an inspector?

A A worker is dismissed as a result of victimisation.
B Safety guards are missing or broken.
C A worker is being discriminated against.
D None of the above (1)

1.4 An example of a non-critical incident is:

A A huge fire
B An injury
C Flooding
D A windstorm

(1)

1.5 In an RLC circuit, the resistor (R) provides a constant resistance against the flow of current while the supply voltage varies sinusoidally. This causes the current to be … the voltage.

A lagging
B leading
C in phase with
D out of phase with (1)

1.6 The phase angle between the current and supply voltage in an RLC circuit is determined by the …

A inductive reactance (X_L).
B capacitive reactance (X_C).
C resistance (R).
D impedance (Z). (1)

1.7 The quality factor (Q) of a resonant circuit is usually determined by the component that loses the most …

A quality.
B reactance.
C power.
D inductance. (1)

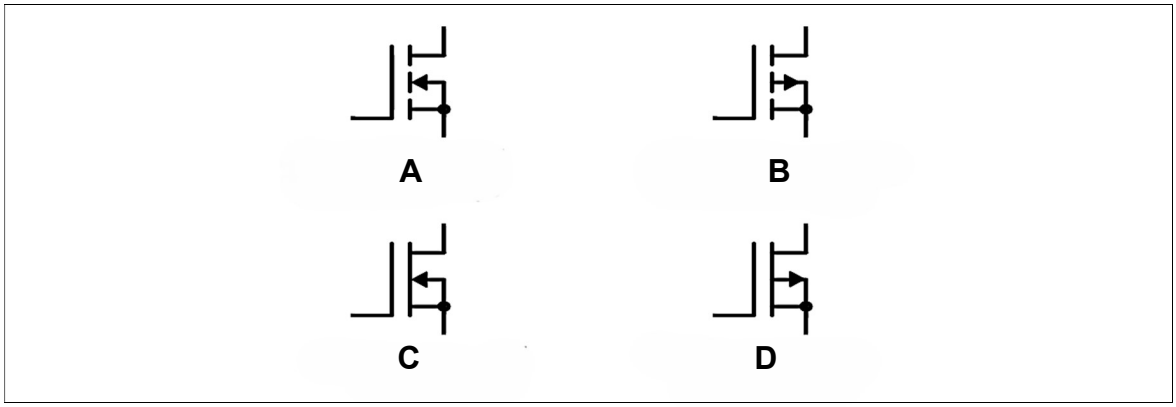
1.8 In an RLC resonant circuit with a supply of 50 V / 378 Hz, the bandwidth's lowest frequency (f_1) is 256 Hz, and the highest frequency (f_2) is 500 Hz. The resonant frequency of the circuit will be … Hz.

A 244
B 256
C 378
D 500 (1)

1.9 The field-effect-transistor (FET) is a device that relies on the development of …

A a magnetic field within the device to control the flow of current.
B an electric field within the device to control the voltage.
C a magnetic field within the device to control the voltage.
D an electric field within the device to control the flow of current. (1)

1.10 Study the MOSFET symbols below and choose the correct symbol for a P-channel depletion-mode MOSFET.



(1)

1.11 The Darlington pair silicon transistor requires … between the base and emitter terminals to switch on.

A 0,3 V
B 0,7 V
C 0,707 V
D 1,4 V (1)

1.12 The 741 operational amplifier is housed in an 8-pin DIL (Dual In-Line) package. The pin number for the non-inverting input is:

A 2
B 3
C 7
D 6 (1)

1.13 When a trigger pulse is received, only one pulse cycle consisting of a "high" and a "low" is generated. This is a summarised operational description of a:

A Astable multivibrator
B Bistable multivibrator
C Monostable multivibrator
D Free-running multivibrator (1)

1.14 In a passive RC differentiator, the shape of the output waveform is determined by:

A The rate at which the capacitor charges and discharges
B The value of the capacitor
C The value of the resistor
D All of the above (1)

1.15 Hysteresis is the … between cause and effect.

A difference
B time delay
C product
D change (1)

[15]

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

2.1	A sense of responsibility is an example of a good work ethic. Name TWO other examples of responsible behaviour in the workplace that will contribute to the success of a business.	
		(2)

2.2	When circuit boards are etched, chemicals such as ferric chloride are used. Name TWO examples of personal protective equipment (PPE) that should be used when working with chemicals.	
		(2)

2.3	State the first step to take when you want to help someone who is being shocked by electricity.	
		(1)

2.4	Risk analysis and risk management involve five steps. Arrange the letters **A** to **E** for each description below in the correct order to show the steps that should be taken. Write only the letter (**A** to **E**).	
	RISK ANALYSIS **DESCRIPTION** **A** Analyse the risk. **B** Identify the risks. **C** Implement precautionary measures. **D** Determine the working conditions. **E** Evaluate and prioritise the risks.	
	STEP 1: _____	
	STEP 2: _____	
	STEP 3: _____	
	STEP 4: _____	
	STEP 5: _____	(5)

[10]

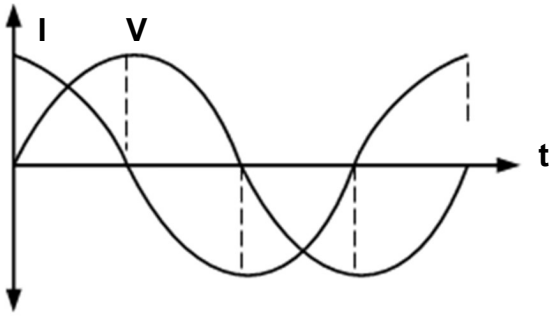
QUESTION 3: RLC CIRCUITS

3.1	Define the following with reference to RLC circuits:	
3.1.1	Quality factor (Q) of an inductor	
		(2)

3.1.2	Selectivity	
		(2)

3.1.3	Impedance	
		(3)

3.2	A circuit consists of a pure inductor and a light bulb connected in series to an alternating current (AC) power source. Explain what will happen to the brightness of the light bulb if the frequency of the supply is increased.	
		(3)

3.3	Refer to the voltage and current waveforms in FIGURE 3.3 below and answer the questions that follow.	
		
	FIGURE 3.3: WAVEFORM DIAGRAM	

3.3.1	Explain whether the waveforms shown in FIGURE 3.3 are found in a purely inductive or purely capacitive circuit.	
		(3)

3.3.2	What effect will a series resistor have on the phase angle between the voltage and current if it is added to the circuit?	
		(2)

3.4 Refer to FIGURE 3.4 below, which shows the circuit diagram of a tuning circuit. The tuning circuit consists of a 27,32 µH inductor and a variable capacitor. The radio station being listened to has a tuning frequency of 92,7 MHz (FM).

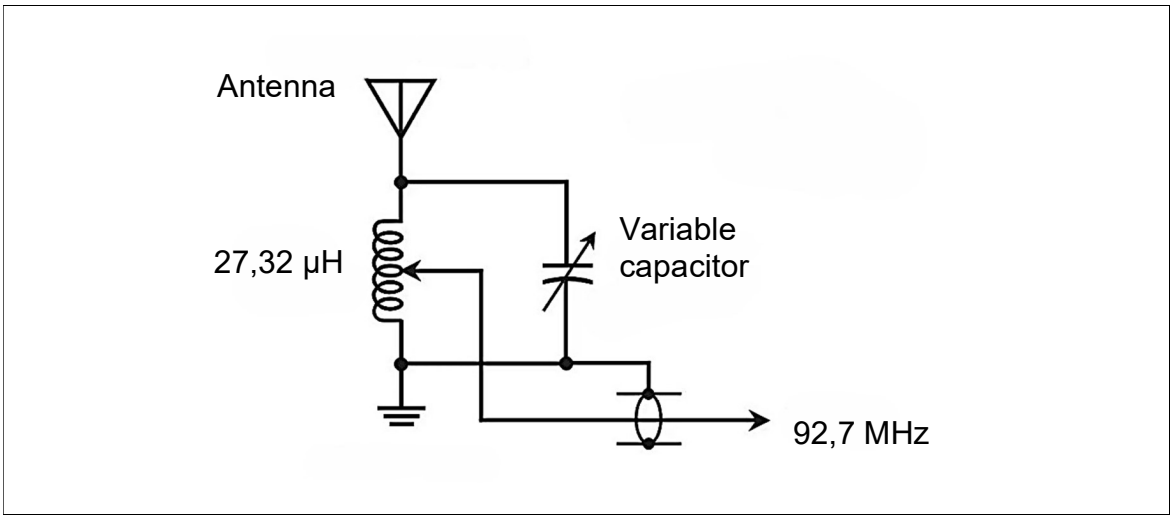


FIGURE 3.4: TUNER CIRCUIT

Given:

L = 27,32 µH
f_r = 92,7 MHz

3.4.1	Calculate the value to which the variable capacitor must be set to allow the circuit to resonate at 92,7 MHz so that the radio broadcast can be received. The final answer must be given in microfarads (µF).	
		(3)

3.4.2	Provide the missing word in the following sentence. A tuning circuit is also referred to as an “LC circuit”, resonant circuit, or … circuit.	
		(1)

3.5 Refer to the incomplete RLC circuit phasor diagram in FIGURE 3.5 below and answer the questions that follow.

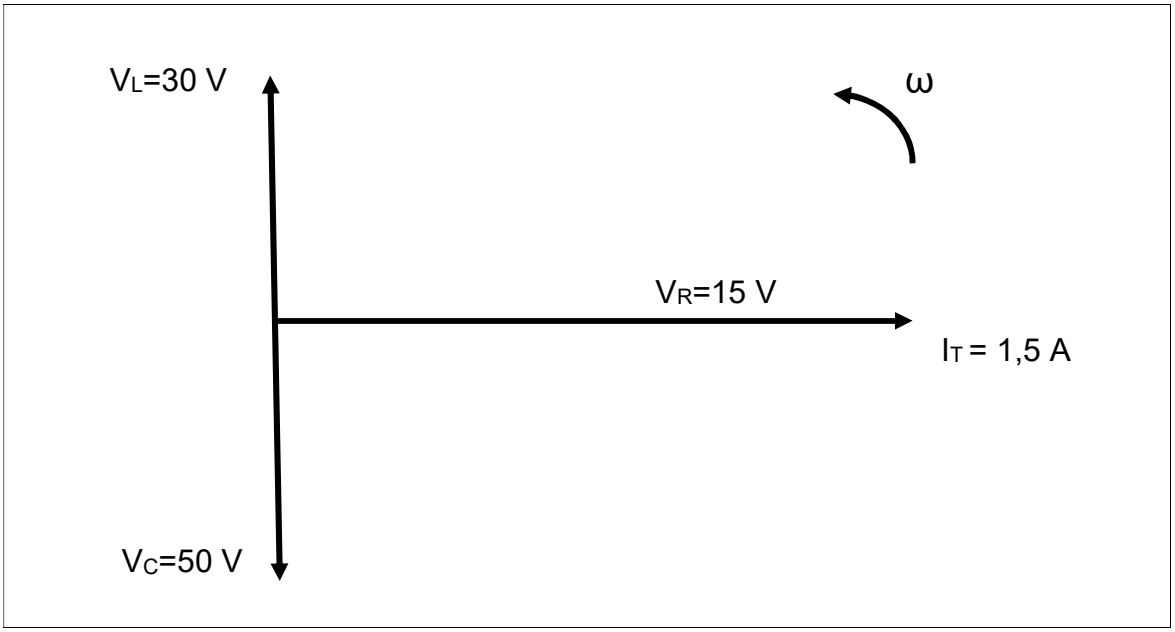


FIGURE 3.5: RLC PHASOR DIAGRAM

Given:

$V_R = 15$ V
$V_L = 30$ V
$V_C = 50$ V
$V_T = 25$ V
$I_T = 1,5$ A

3.5.1	State whether the phasor diagram represents a series or parallel circuit and explain your answer.	
		(2)

3.5.2	Complete the phasor diagram for FIGURE 3.5 on the diagram above.	(3)

3.5.3	Calculate the impedance of the circuit.	
		(3)

3.5.4	Calculate the phase angle (ø) of the circuit and indicate whether the angle is leading or lagging.	
		(4)

3.5.5	Calculate the inductive reactance (X_L) of the inductor.	
		(3)

3.5.6	Calculate the inductance of the inductor if the supply frequency is 30 Hz.	
		(3)

3.6	List THREE characteristics of a parallel resonant RLC circuit.	
		(3)

3.7 FIGURE 3.7 below shows a parallel RLC circuit that consists of a 250 Ω resistor, an unknown value inductor and a 795 nF capacitor, all connected across a 50 V/1 kHz supply. Study the figure and answer the questions that follow.

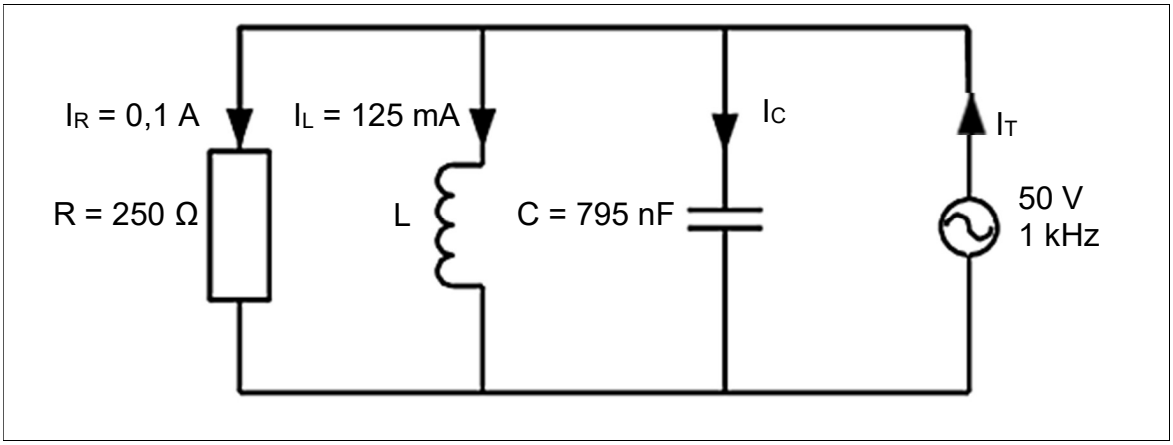


FIGURE 3.7: PARALLEL RLC CIRCUIT

Given:

V_T = 50 V
f = 1 kHz
C = 795 nF
R = 250 Ω
I_R = 0,1 A
I_L = 125 mA

3.7.1	Calculate the capacitive reactance (X_C) of the capacitor.	
		(3)

3.7.2	Calculate the current through the capacitor (I_C).	
		(3)

3.7.3	Calculate the total current that flows through the circuit (I_T).	
		(3)

3.8 FIGURE 3.8 below shows a frequency curve illustrating the measurement of bandwidth in a parallel resonant circuit. Study this figure and answer the questions that follow.

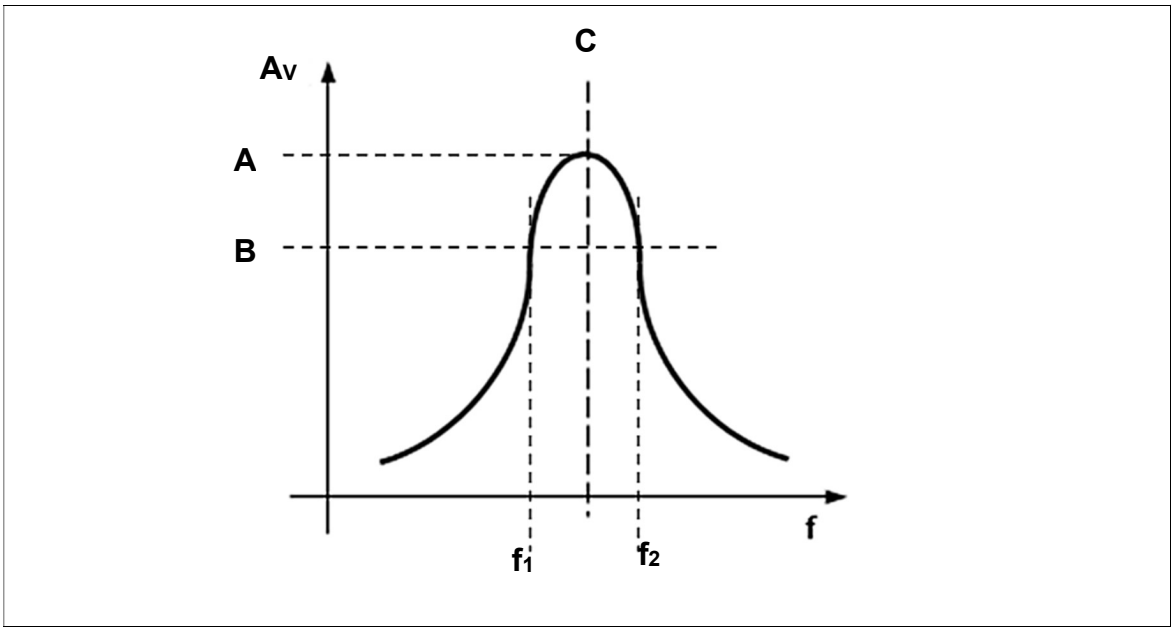


FIGURE 3.8: PARALLEL FREQUENCY CURVE

3.8.1	Identify labels **A** to **C**.	
	A:	
	B:	
	C:	(3)

3.8.2	When the L/C ratio is changed, it influences the shape and selectivity of the curve shown in FIGURE 3.8 above. Name TWO of the effects of increasing the ratio.	
		(2)

3.8.3	Calculate the bandwidth (BW) of the curve if f_1 = 2 450 Hz and f_2 = 2 550 Hz.	
		(3)

3.8.4	Calculate the quality factor (Q) if the circuit is resonating at 2 500 Hz.	
		(3)

[60]

QUESTION 4: SEMICONDUCTOR DEVICES

4.1	The field-effect transistor (FET) has largely replaced the traditional bipolar junction transistor (BJT) due to the advantages it offers. Name TWO of these advantages.	
		(2)

4.2 FIGURE 4.2 below shows a junction field-effect transistor (JFET) connected to direct current power sources, with the gate and source bias being adjustable. Study the figure and answer the questions that follow.

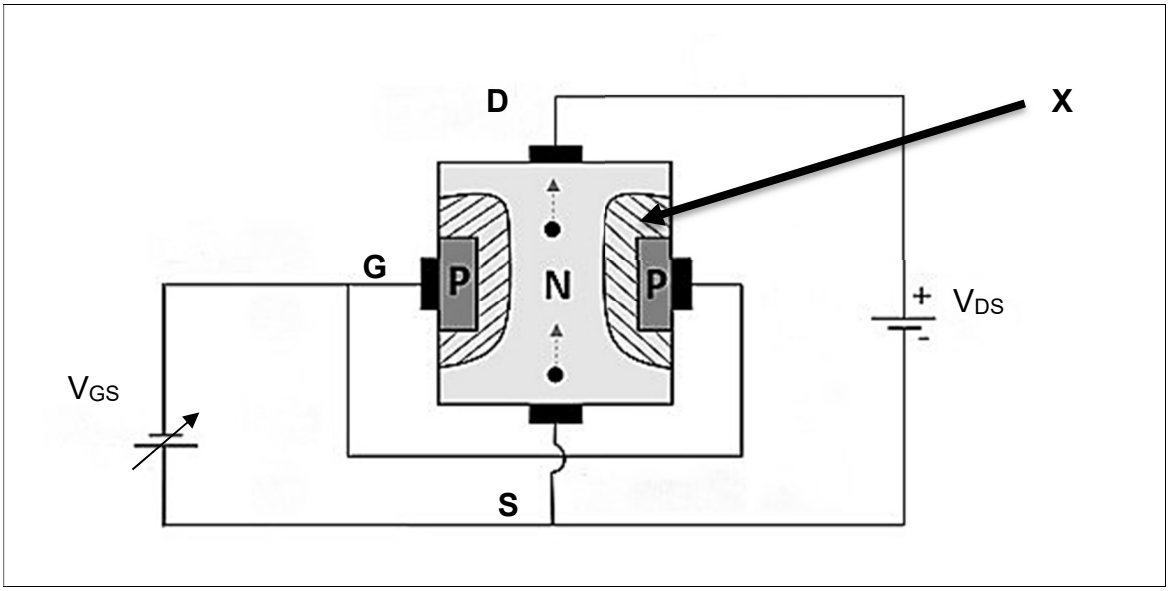


FIGURE 4.2: JUNCTION FIELD-EFFECT TRANSISTOR (JFET)

4.2.1	What is the shaded area called, to which arrow **X** is pointing?	
		(1)

4.2.2	Briefly explain the operation of the JFET shown in FIGURE 4.2 above when the adjustable voltage (V_{GS}) is increased.	
		(4)

4.3	The FET has been developed into a wide range of devices, with two basic types, namely the JFET and the MOSFET. Explain the main difference between the *JFET* and the *MOSFET*, and the advantage that this difference offers.	
		(2)

4.4 FIGURE 4.4 below shows the construction of an N-type JFET. Answer the questions that follow.

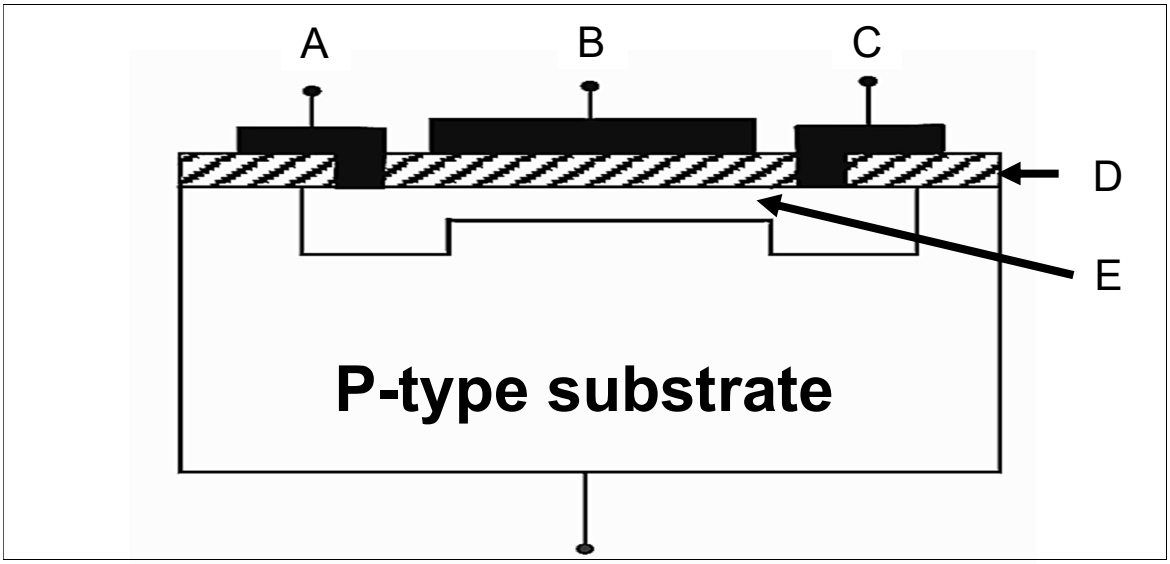


FIGURE 4.4: CONSTRUCTION OF AN N-TYPE MOSFET

4.4.1	MOSFETs are available in enhancement and depletion modes in terms of construction and operation. Identify the MOSFET shown in FIGURE 4.4 above.	
		(1)

4.4.2	Identify the construction labels **A** to **E** in FIGURE 4.4 above.	
	A:	
	B:	
	C:	
	D:	
	E:	(5)

4.5	Name THREE uses of the unijunction transistor (UJT).	
		(3)

4.6	As soon as the unijunction transistor switches on due to sufficient emitter voltage (Ve), a phenomenon occurs that is contradictory to Ohm's Law. Name and explain this phenomenon.	
		(3)

4.7 FIGURE 4.7 below shows the UJT characteristic curve. Identify parts **A** to **D**.

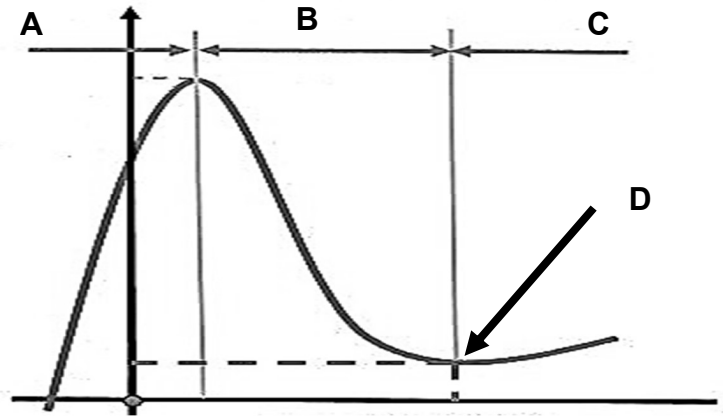


FIGURE 4.7: UJT CHARACTERISTIC CURVE

	A:	
	B:	
	C:	
	D:	(4)

4.8 Refer to the motor speed control circuit in FIGURE 4.8 below and answer the questions that follow.

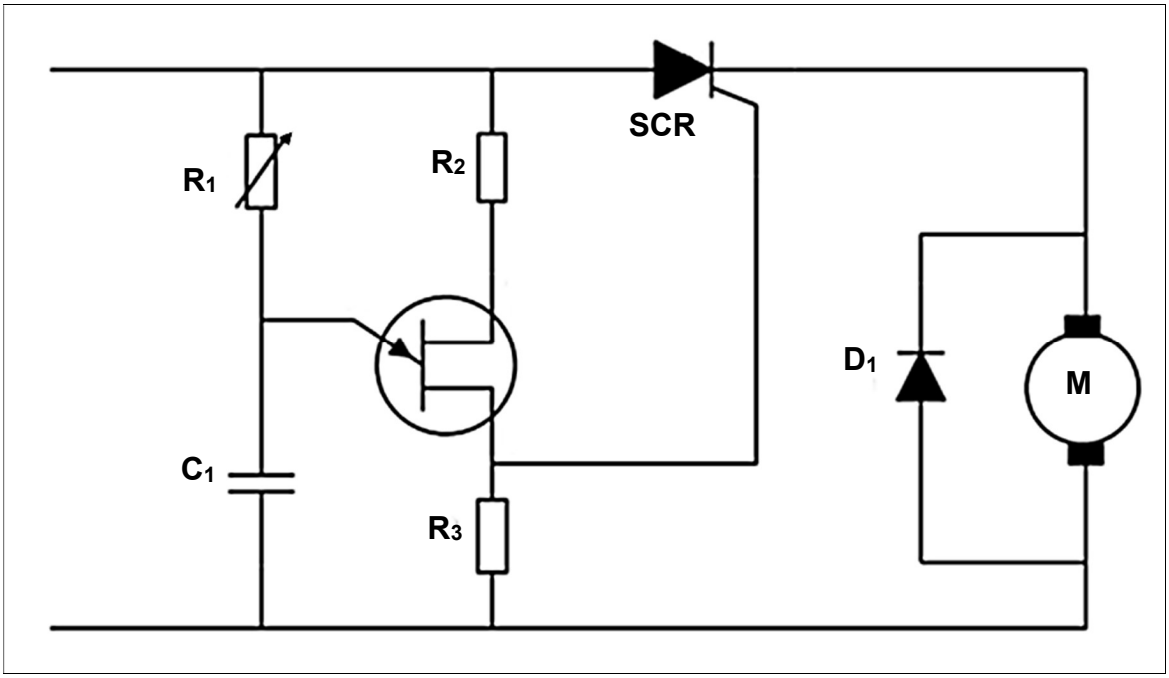


FIGURE 4.8: MOTOR SPEED CONTROL WITH UNIJUNCTION TRANSISTOR

4.8.1	Which components in the circuit determine the frequency/speed of the motor?	
		(2)

4.8.2	The UJT provides positive pulses to the gate of the SCR which determine the motor's speed. What type of waveform does the emitter of the UJT receive?	
		(1)

4.8.3	State whether the motor used in FIGURE 4.8 above is a direct current (DC) or alternating current (AC) motor. Explain your answer.	
		(2)

4.9 FIGURE 4.9 below shows the Darlington transistor used to switch a relay. Answer the questions that follow.

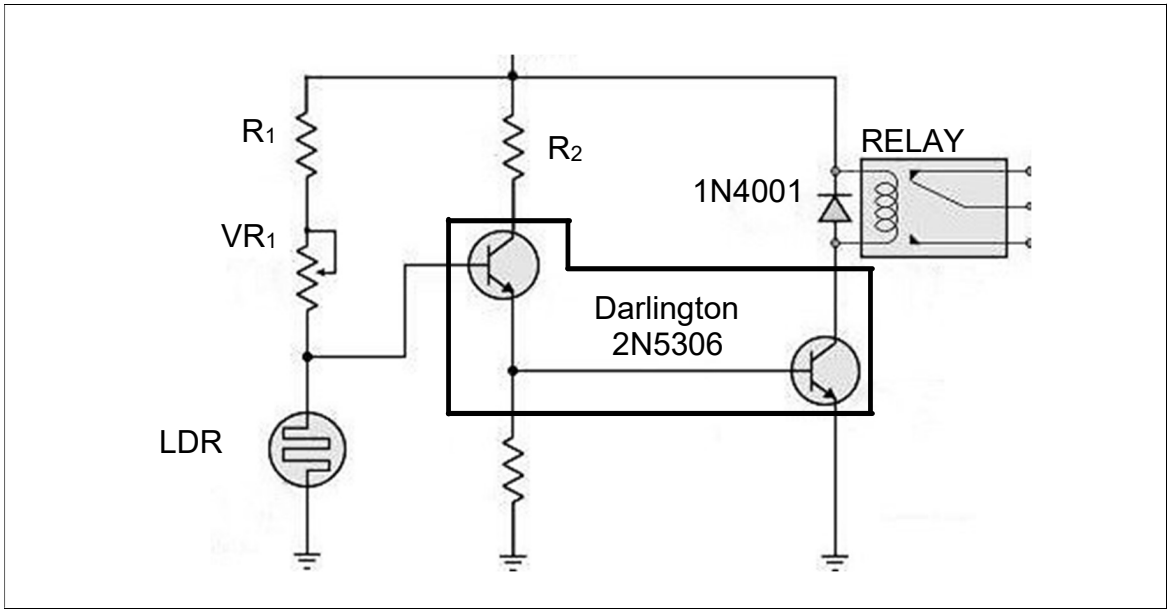


FIGURE 4.9: DARLINGTON TRANSISTOR AS A RELAY SWITCH

4.9.1	Explain why a Darlington transistor is suitable for activating a relay.	
		(2)

4.9.2	Provide ONE use of the circuit in FIGURE 4.9 above where an LDR is used as a sensor.	
		(1)

4.9.3	Explain why a 1N4001 diode is connected in parallel with the relay, and state what this diode is called in practice.	
		(3)

4.10 Refer to the non-inverting op-amp circuit in FIGURE 4.10 below and answer the questions that follow.

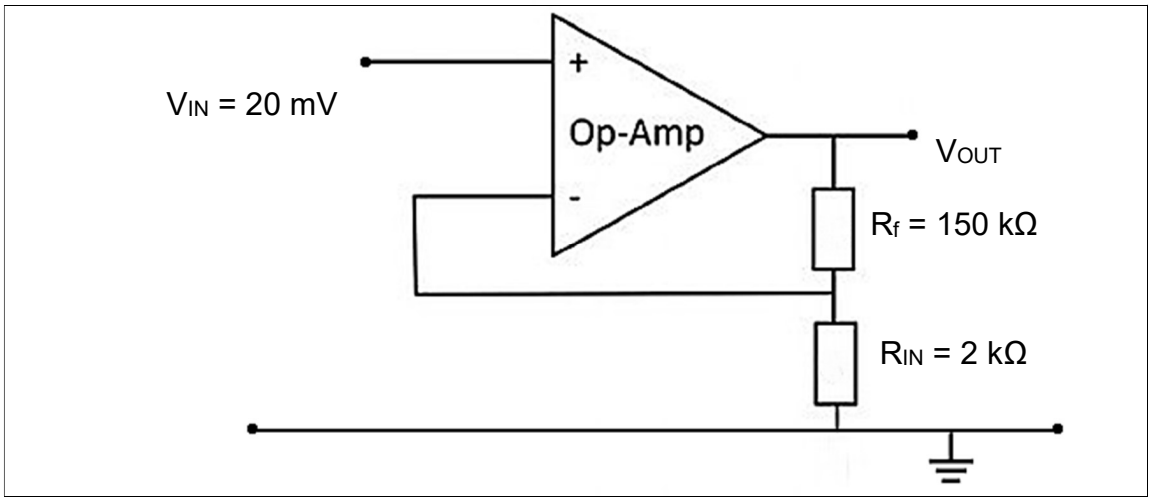


FIGURE 4.10: NON-INVERTING OP-AMP CIRCUIT

4.10.1	State ONE reason why this operational amplifier circuit makes use of closed loop feedback in its construction.	
		(1)

4.10.2	Calculate the output voltage of the op-amp circuit using the given information. Given: V_{IN} = 20 mV R_f = 150 kΩ R_{IN} = 2 kΩ	
		(3)

4.11	The 555 timer has a wide range of applications. Name TWO applications of the 555 timer.	
		(2)

4.12	The 555 timer has certain operating limitations, such as the supply voltage needs to be between +5 V and +18 V. What is the maximum current value that can be handled by a 555 timer?	
		(1)

4.13	State what is meant by the term 'active low trigger' in the operation of the 555 timer.	
		(2)

[45]

QUESTION 5: SWITCHING CIRCUITS

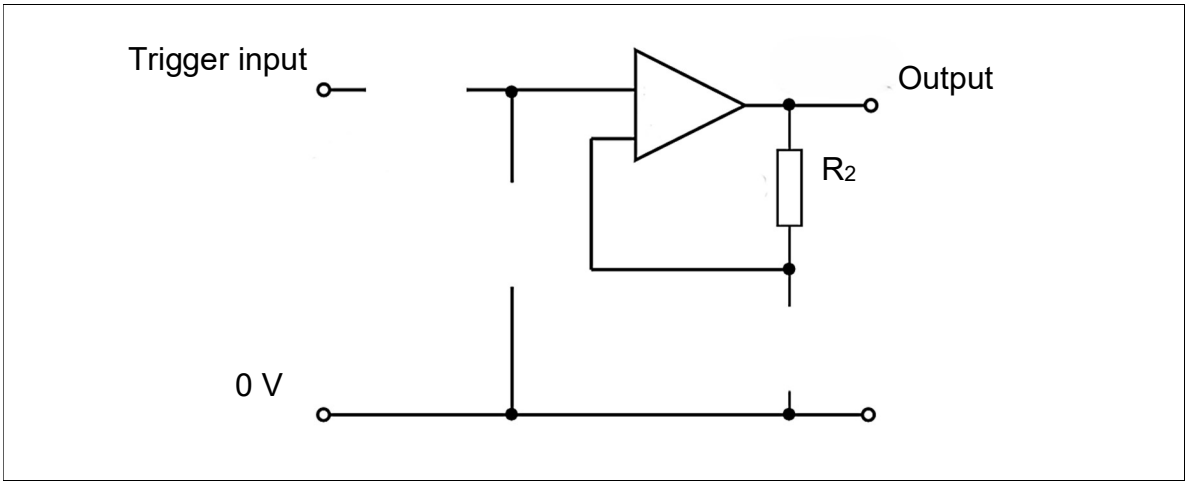
5.1 The table below shows various types of multivibrators in COLUMN A, and possible applications for multivibrators in COLUMN B. Choose TWO applications from COLUMN B that best correspond with each type of multivibrator in COLUMN A. Write only the letters next to the multivibrator type.

COLUMN A MULTIVIBRATOR TYPES	COLUMN B COMMON USES
5.1.1 Monostable Multivibrator	A Flashing lights
5.1.2 Astable Multivibrator	B Pulse width modulation
5.1.3 Bistable Multivibrator	C Tone generation
	D Data storage
	E Debouncing switches
	F Digital logic circuits

MULTIVIBRATOR TYPES	CORRECT APPLICATIONS (Choose TWO letters.)	
5.1.1 Monostable Multivibrator	..... ;	(2)
5.1.2 Astable Multivibrator	..... ;	(2)
5.1.3 Bistable Multivibrator	..... ;	(2)

5.2	Explain the working principle of the bistable multivibrator with reference to the inputs and outputs of the circuit.	
		(2)

5.3 FIGURE 5.3 below shows the incomplete circuit diagram of an op-amp bistable multivibrator. Complete the circuit diagram by filling in the missing components, connections and labels.



(5)

FIGURE 5.3: OP-AMP BISTABLE MULTIVIBRATOR

5.4 FIGURE 5.4 below shows input pulses received from a push button switch. Answer the questions that follow.

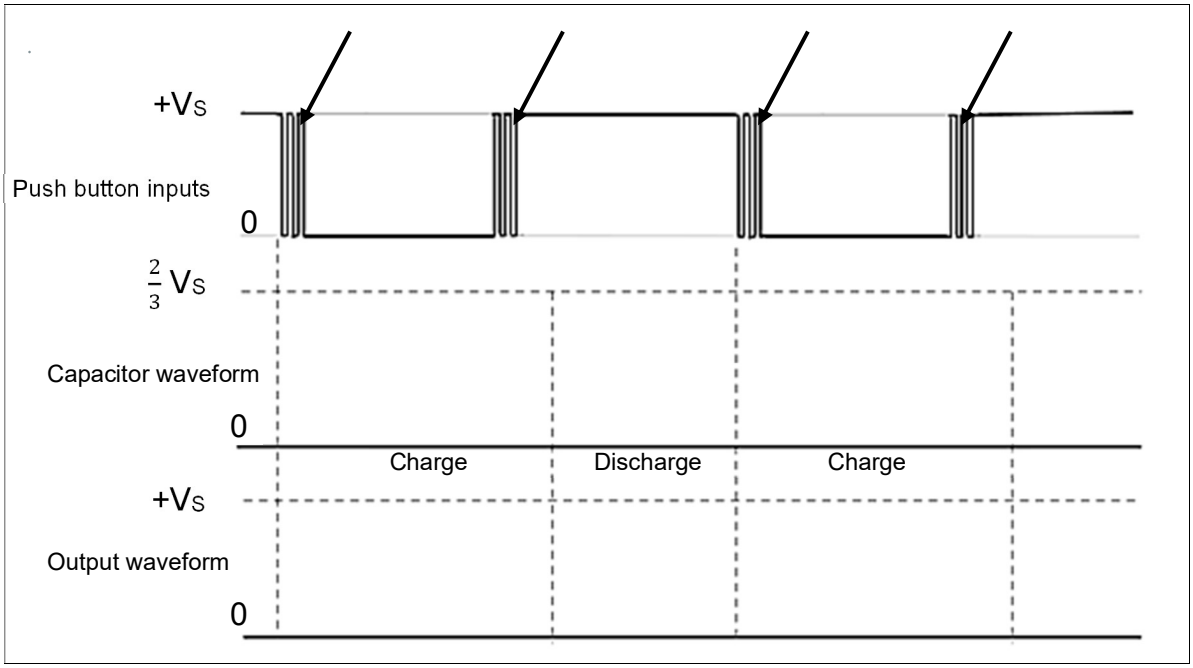


FIGURE 5.4: PUSH BUTTON INPUTS

5.4.1	The arrows indicate distortion that occurs at the beginning and end of each input pulse. Explain what happens here and state what this phenomenon is called.	
		(3)

5.4.2	Which 555 circuit is used to solve this problem when making use of mechanical switches as inputs?	
		(1)

5.4.3	In FIGURE 5.4 above, draw the capacitor's charge and discharge curve, as well as the output of the circuit that provides the solution to this problem.	(5)

5.5 Refer to the 555 astable multivibrator circuit in FIGURE 5.5 below and answer the questions that follow.

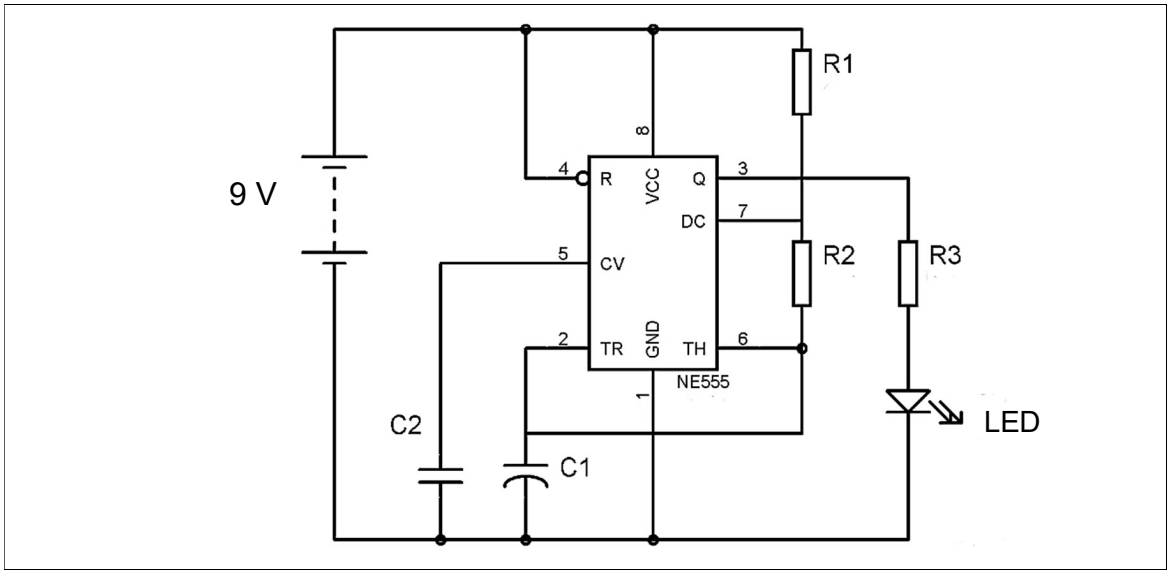


FIGURE 5.5: 555 ASTABLE MULTIVIBRATOR CIRCUIT

5.5.1	Provide another name by which the astable multivibrator is known.	
		(1)

5.5.2	Provide the full names of the TWO pins of the 555 IC that determine the period in which the light-emitting diode (LED) switches "ON" and "OFF".	
		(2)

5.5.3	Identify the capacitor that sets the switching period of the circuit.	
		(1)

5.5.4	Provide any TWO key features by which you can recognise a 555 astable multivibrator circuit.	
		(2)

5.6 FIGURE 5.6 shows the input wave from a humidity sensor to a Schmitt trigger sprinkler system. Answer the questions that follow.

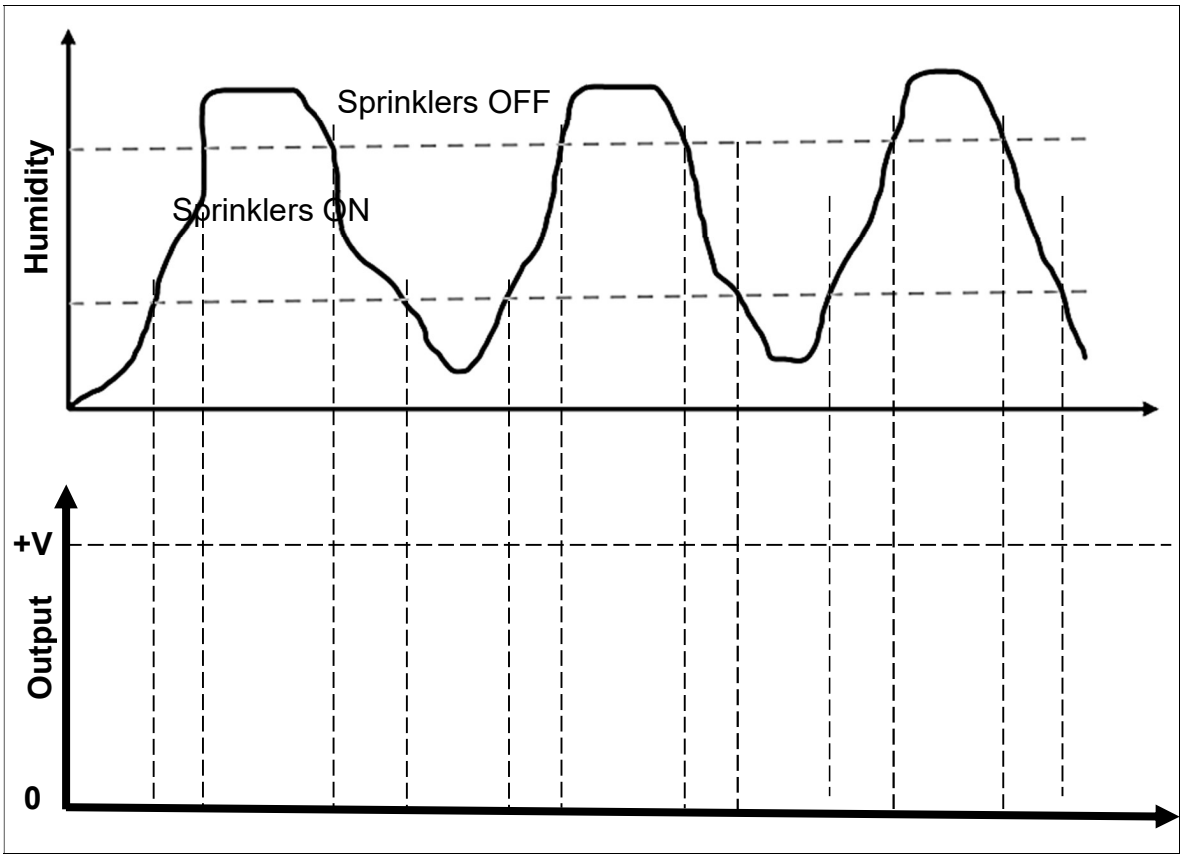


FIGURE 5.6: SCHMITT TRIGGER SPRINKLER SYSTEM

5.6.1	State what the switching delay between the sprinklers turning on and off in this system is called.	
		(1)

5.6.2	State the type of feedback used in this type of circuit.	
		(1)

5.6.3	Provide any TWO other applications for a Schmitt trigger circuit.	
		(2)

5.6.4	In FIGURE 5.6 above, draw with reference to the input, the output wave of an inverting Schmitt trigger that is used to switch the sprinkler system ON and OFF.	(5)

5.7 FIGURE 5.7 below shows a comparator with INPUT and OUTPUT waveforms. Answer the questions that follow.

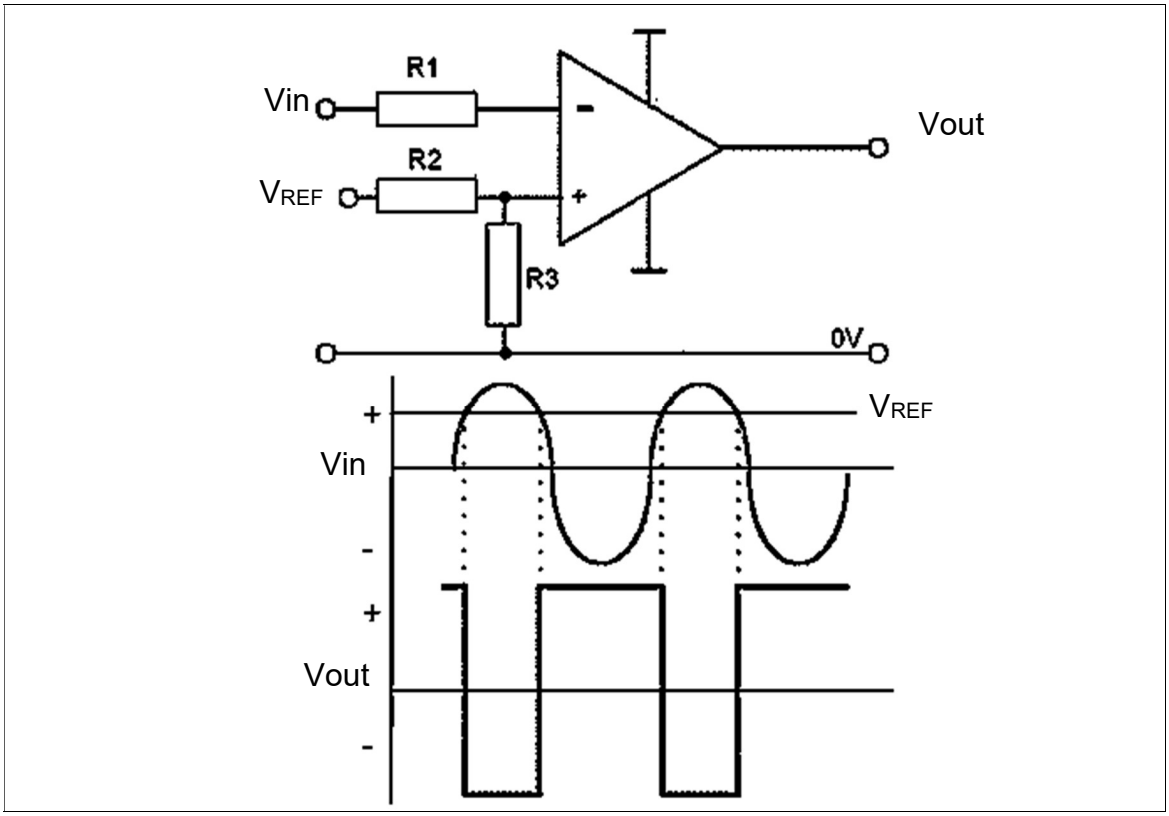


FIGURE 5.7: COMPARATOR CIRCUIT WITH INPUTS AND OUTPUTS

5.7.1	Study the circuit and waveforms and state whether this is an inverting or non-inverting comparator.	
		(1)

5.7.2	Give TWO reasons for your answer to QUESTION 5.7.1.	
		(2)

5.7.3	Does this circuit operate in open-loop mode or closed-loop mode? Motivate your answer.	
		(2)

5.7.4	Comparators can be used to convert waveforms into square waves. Name TWO additional uses for a comparator.	
		(2)

5.7.5	Briefly explain the operation of the circuit shown in FIGURE 5.7.	
		(5)

5.8 FIGURE 5.8 below shows the circuit of a summing amplifier with two inputs, V_1 and V_2. Answer the questions that follow.

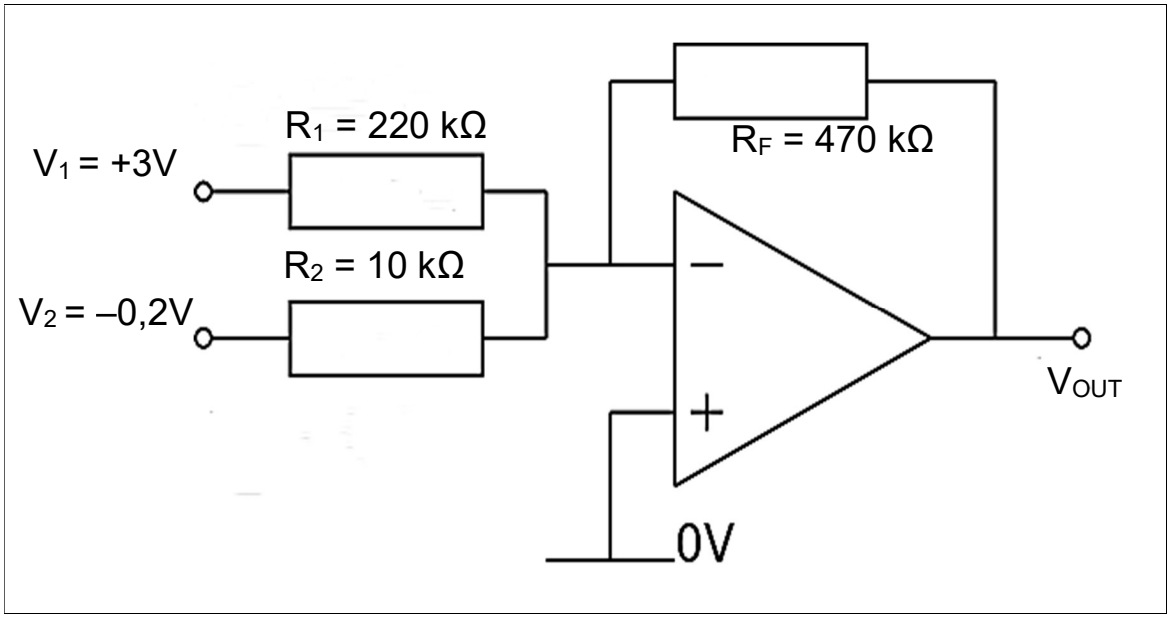


FIGURE 5.8: SUMMING AMPLIFIER

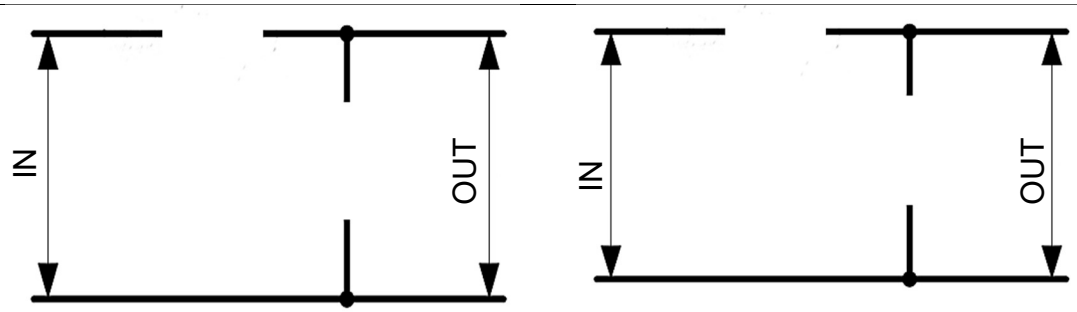
5.8.1	The summing amplifier is especially used in audio mixers that combine different input signals. The gain of the different inputs must be able to be amplified and attenuated separately. Explain how this is achieved.	
		(2)

5.8.2	Calculate the output voltage of the op-amp circuit in FIGURE 5.8 above.	
		(3)

5.8.3	Briefly state what will happen to the output voltage if the feedback resistor (R_F) value is halved, and why this happens.	
		(2)

5.8.4	Complete the following statement about the summing amplifier by filling in the missing words.	
	The gain for each input is the ratio of the ..... to the ..... in each of the input branches.	(2)

5.9 Integrator and differentiator circuits perform mathematical integration and differentiation on input signals, converting them into new waveforms. Answer the following questions about these circuits.

5.9.1	Complete the circuit diagrams for the passive *differentiator* and passive *integrator* below to show the difference between the two circuits.	
		
	PASSIVE DIFFERENTIATOR **PASSIVE INTEGRATOR**	(4)

5.9.2	Provide TWO reasons why using an op-amp in your differentiator and integrator circuit is better than using only passive components.	
		(2)

5.9.3	State ONE application of an integrator circuit.	
		(1)

5.9.4 FIGURE 5.9.4 below shows a sine wave that is the input for an inverting op-amp differentiator.

Draw the output waveform that the differentiator will produce for this input on the figure below.

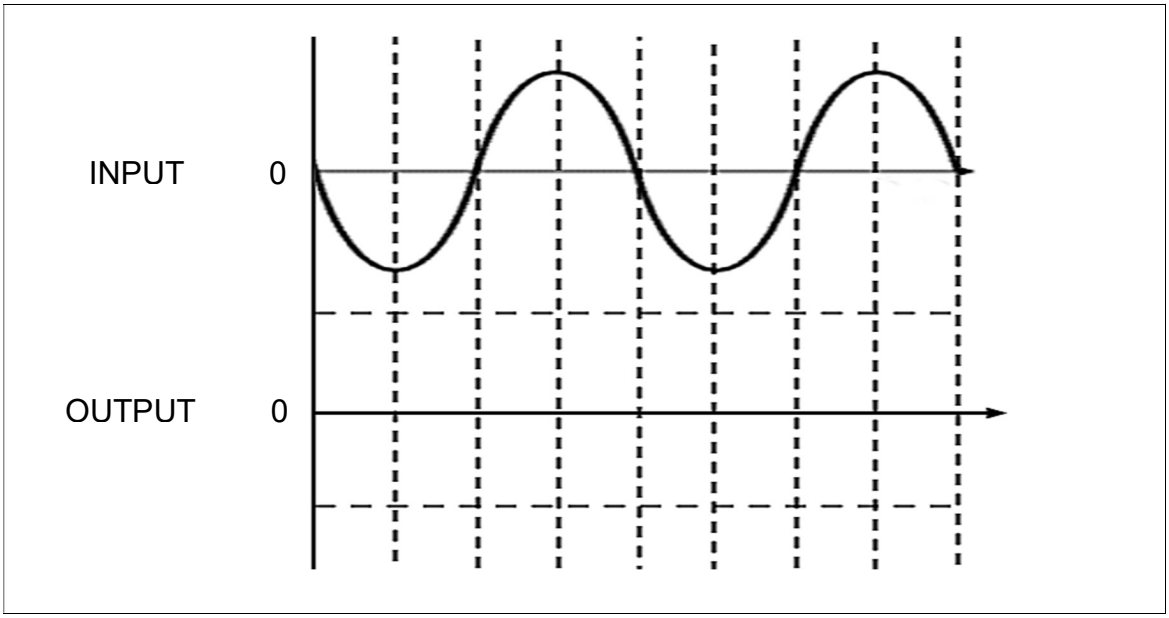


FIGURE 5.9.4: INVERTING OP-AMP DIFFERENTIATOR WAVEFORMS (5)

[70]

ADDITIONAL SPACE

ADDITIONAL SPACE

TOTAL: 200

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FORMULA SHEET

RLC CIRCUITS

$$P = V \times I \times \cos\theta$$

$$X_L = 2\pi fL$$

$$X_C = \frac{1}{2\pi fC}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}} \quad \textbf{OR} \quad f_r = \frac{f_2 + f_1}{2}$$

$$BW = \frac{f_r}{Q} \quad \textbf{OR} \quad BW = f_2 - f_1$$

Series

$$V_R = IR$$

$$V_L = I X_L$$

$$V_C = I X_C$$

$$I_T = \frac{V_T}{Z} \quad \textbf{OR} \quad I_T = I_R = I_C = I_L$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$V_T = \sqrt{V_R{}^2 + (V_L - V_C)^2} \quad \textbf{OR} \quad V_T = IZ$$

$$\text{Cos}\,\theta = \frac{R}{Z} \quad \textbf{OR} \quad \text{Cos}\,\theta = \frac{V_R}{V_T}$$

$$Q = \frac{X_L}{R} = \frac{X_C}{R} = \frac{V_L}{V_T} = \frac{V_C}{V_T} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

Parallel

$$V_T = V_R = V_L = V_C$$

$$I_R = \frac{V_T}{R}$$

$$I_C = \frac{V_T}{X_C}$$

$$I_L = \frac{V_T}{X_L}$$

$$I_T = \sqrt{I_R{}^2 + (I_L - I_C)^2}$$

$$Z = \frac{V_T}{I_T}$$

$$\text{Cos}\,\theta = \frac{I_R}{I_T}$$

$$Q = \frac{R}{X_L} = \frac{R}{X_C} = \frac{I_L}{I_T} = \frac{I_C}{I_T}$$

SEMICONDUCTOR DEVICES

$$\text{Gain } A_V = \frac{V_{OUT}}{V_{IN}} = -\frac{R_F}{R_{IN}} \qquad A_V = 1 + \frac{R_F}{R_{IN}}$$

$$V_{OUT} = V_{IN} \times \left(-\frac{R_F}{R_{IN}}\right)$$

$$V_{OUT} = V_{IN} \times \left(1 + \frac{R_F}{R_{IN}}\right)$$

SWITCHING CIRCUITS

$$V_{OUT} = -\left(V_1\frac{R_F}{R_1} + V_2\frac{R_F}{R_2} + \ldots V_N\frac{R_F}{R_N}\right)$$

$$\text{Gain } A_V = \frac{V_{OUT}}{V_{IN}} = \frac{V_{OUT}}{(V_1 + V_2 + \ldots V_N)}$$

$$V_{OUT} = -(V_1 + V_2 + \ldots V_N)$$

AMPLIFIERS

$$I_C = \frac{V_C}{R_C} \qquad V_{CC} = V_{CE} + I_C R_C$$

$$V_B = V_{BE} + V_{RE}$$

$$A_V = \frac{V_{OUT}}{V_{IN}}$$

$$A_I = \frac{I_{OUT}}{I_{IN}} \quad \textbf{OR} \quad \beta = \frac{I_C}{I_B}$$

$$A_P = \frac{P_{OUT}}{P_{IN}} \quad \textbf{OR} \quad A_P = A_V \times A_I$$

$$A = \beta_1 \text{ x } \beta_2 \quad \textbf{OR} \quad A_V = A_{V1} \times A_{V2} \times A_{V3}$$

$$P_{IN} = I^2 \times Z_{IN} \quad \textbf{AND} \quad P_{OUT} = I^2 \times Z_{OUT}$$

Oscillation frequency

$$f_o = \frac{1}{2 \times \pi\sqrt{LC}} \quad \textbf{OR} \quad f_o = \frac{1}{2 \times \pi\sqrt{6}RC}$$

GAIN IN DECIBELS

$$A_I = 20\log_{10}\frac{I_{OUT}}{I_{IN}}$$

$$A_V = 20\log_{10}\frac{V_{OUT}}{V_{IN}}$$

$$A_P = 10\log_{10}\frac{P_{OUT}}{P_{IN}}$$

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