



Province of the
EASTERN CAPE
EDUCATION

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Provinsie van die Oos Kaap: Departement van Onderwys
Porafensie Ya Kapa Botjahabela: Letapha la Thuto

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2026

ELECTRICAL TECHNOLOGY: ELECTRONICS

MARKS: 200

TIME: 3 hours

This question paper consists of 18 pages, including a 2-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of SIX questions.
2. Sketches and diagrams must be large, neat and fully labelled.
3. Show ALL calculations and round off answer correctly to TWO decimal places.
4. Number the answers correctly according to the numbering system used in this question paper.
5. You may use a non-programmable calculator.
6. Show the units for ALL answers of calculations.
7. A formula sheet is provided at the end of this question paper.
8. Write neatly and legible.

QUESTION 1 MULTIPLE-CHOICE QUESTIONS

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.15) in the ANSWER BOOK, for example, 1.16 D.

- 1.1 The meaning of the term *health and safety standard* is ...
- A a standard used to prevent people from getting ill.
 - B any standard, irrespective of whether or not it has the force of law, which, if applied for the purposes of this Act, will in the opinion of the minister promote the attainment of an object of this Act.
 - C a standard used to protect people from very dangerous and contagious diseases such as Covid-19.
 - D All of the above. (1)
- 1.2 The reference of a phasor diagram for a parallel RLC circuit is voltage. The reason for this is ...
- A resistance in parallel divide the current and the voltage stays the same.
 - B resistance in parallel divide the voltage and the current stays the same.
 - C current is inversely proportional to the resistance.
 - D voltage is directly proportional to the resistance. (1)
- 1.3 In a pure capacitive circuit, the capacitive reactance will ... if the frequency decreases.
- A increase
 - B half
 - C stay the same
 - D decrease (1)
- 1.4 Which ONE of the following is TRUE for a series RLC circuit at resonance?
- A The capacitive reactance is equal to the inductive reactance.
 - B The current is 0 A.
 - C The resistance of the circuit is not equal to the impedance of the circuit.
 - D The phase angle is 90° . (1)
- 1.5 A device which transfers current from a low resistance input circuit to a high resistance output circuit is called a/an ...
- A amplifier.
 - B transducer.
 - C transistor.
 - D transferer. (1)
- 1.6 Pin 2 of a 555 timer IC is the ...
- A ground.
 - B supply voltage.
 - C output.
 - D trigger. (1)

- 1.7 Which ONE of the following is a characteristic of an ideal op amp?
- A The ideal op amp has low gain.
 - B The input impedance of an ideal op amp is almost non existing low.
 - C The output impedance is extremely low, between $50\ \Omega$ and $100\ \Omega$.
 - D The ideal op amp will have a very narrow bandwidth to amplify only signals of a predetermined frequency. (1)
- 1.8 A passive RC circuit with its resistor across the output terminals forms a differentiator circuit. It produces an output signal which is...
- A indirectly proportional to the rate of change of the input signal.
 - B indirectly proportional to the rate of change of the supply voltage.
 - C directly proportional to the rate of change of the supply voltage.
 - D directly proportional to the rate of change of the input signal. (1)
- 1.9 With reference to FIGURE 1.9 below, the function of the $10\text{ k}\Omega$ resistor is ...

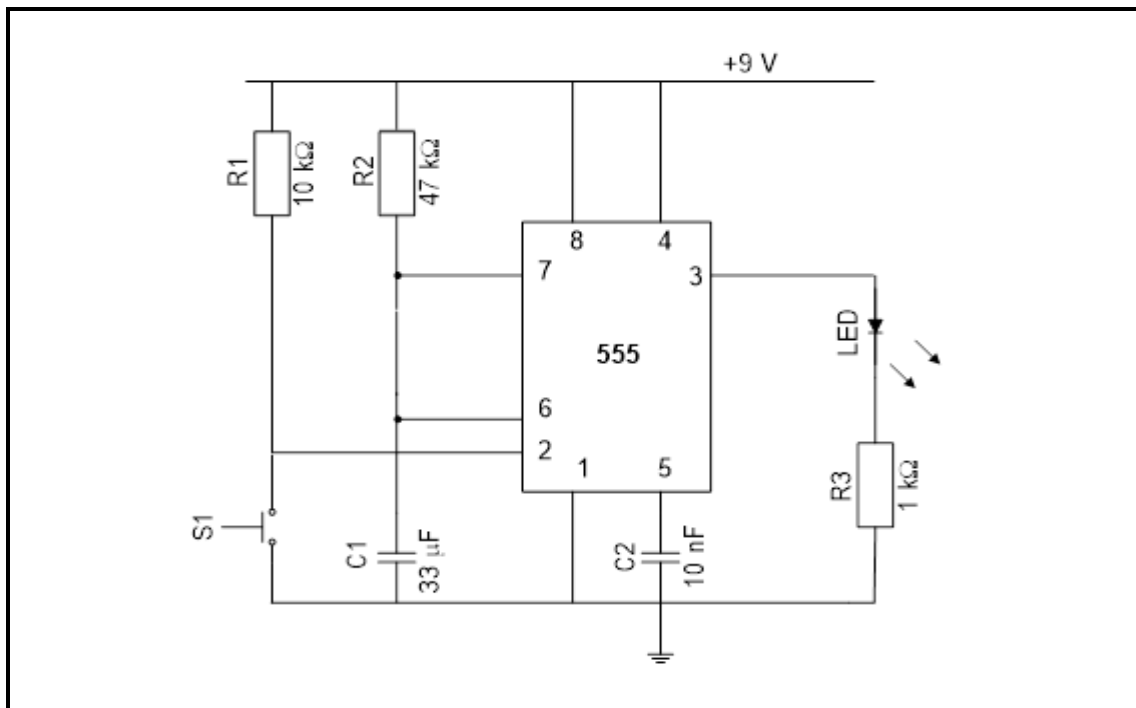


FIGURE 1.9

- A to protect the LED from over current.
- B to protect the 555 timer IC from over current.
- C a pull up resistor to prevent the voltage from floating.
- D a pull-down resistor to prevent the voltage from floating. (1)

1.10 With reference to FIGURE 1.10 below, the function of C_1 is to ...

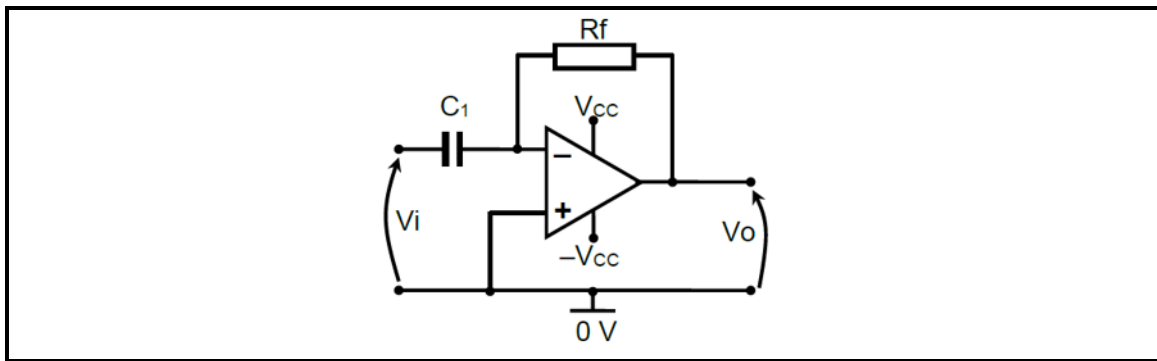


FIGURE 1.10

- A feed the entire signal back to the input.
 - B feed back a small part of the signal to the input.
 - C couple the previous output stage with an input stage.
 - D allow the input signal to partially bypass the op amp.
- (1)

1.11 The operating voltage of the 555 timer IC is ...

- A between +5 V and +18 V.
 - B between -5 V and +5 V.
 - C between -18 V and +18 V.
 - D between -18 V and +5 V.
- (1)

1.12 In class A biasing of an amplifier, the Q point is chosen to lie ...

- A right at the bottom of the load line right at the cut-off point.
 - B just within the active operating region of the amplifier.
 - C right down below the cut-off region of the amplifier.
 - D in the centre of the active region of the amplifier.
- (1)

1.13 With reference to the transformer coupling amplifier, it is referred to as acting as a buffer. This means that ...

- A it isolates the input and output stages to prevent feedback.
 - B it will correctly match two different impedances while at the same time separating their DC circuits.
 - C it will correctly match two different impedances while at the same time allow their DC circuits to pass.
 - D it combines the input and output signals to provide a very large, stable output.
- (1)

1.14 Which ONE of the following is an advantage of a RC coupled amplifier?

- A Low voltage and power gain as the effective resistance is reduced.
 - B Not suitable for low-frequency amplification.
 - C Offers a varying gain over a specific frequency band.
 - D Cheap, economical and compact as it uses only resistors and capacitors.
- (1)

1.15 The output waveform generated by a RC phase shift oscillator will be ...

- A sawtooth.
- B sinusoidal.
- C triangular.
- D square.

(1)
[15]

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

- 2.1 Siphon is an apprentice electrician working in an electronics workshop. He notices that the supervisor regularly instructs workers to repair live circuits without switching off the power supply. Siphon reports this unsafe practice to management. After reporting the issue, the supervisor begins giving Siphon unpleasant tasks and excludes him from practical training opportunities.

Answer the questions that follow.

- 2.1.1 Identify the action by the supervisor that can be regarded as victimisation. (1)
- 2.1.2 Explain why this behaviour is considered victimisation in the workplace. (1)
- 2.1.3 Suggest ONE appropriate action Siphon can take according to workplace safety and ethics procedures. (1)
- 2.2 Explain the difference between *unsafe acts* and *unsafe conditions*. (2)
- 2.3 Provide ONE practical example of an unsafe act in a workshop. (1)
- 2.4 During a practical lesson in the electronics workshop, learners are required to repair a faulty power supply unit. Before the repair work begins, the technician conducts a quantitative risk analysis by assigning numerical values to the likelihood of electric shock and the severity of possible injury. The analysis shows that the risk level is high if the circuit is tested while live. The technician, therefore, decides that the main supply must be isolated before any repair work is done.

Answer the questions that follow.

- 2.4.1 What is meant by *quantitative risk analysis* in a workshop environment? (1)
- 2.4.2 Identify ONE factor that is considered when calculating risk during quantitative risk analysis. (1)
- 2.4.3 State ONE safety action the technician implemented to reduce the risk. (1)
- 2.5 Name ONE type of emergency in a workshop. (1)
- [10]**

QUESTION 3: RLC CIRCUITS

3.1 Define the following terms with reference to RLC circuits:

3.1.1 *Leading phase angle* with reference to a series RLC circuit (2)

3.1.2 *Bandwidth* (2)

3.2 Draw a fully labelled frequency vs reactance graph to indicate the effect of frequency change on a capacitive reactance. (4)

3.3 A coil with an unknown value is connected in series with a capacitor with a capacitance of $68\ \mu\text{f}$ and a $47\ \Omega$ resistor. The circuit is connected to an alternating current supply which draws a total current of $1,43\ \text{A}$. The voltage drop across the inductor is $4,21\ \text{V}$.

Calculate:

3.3.1 Value of the inductive reactance (3)

3.3.2 The value of the inductor (3)

3.3.3 The total impedance of the circuit (6)

3.3.4 Draw a fully labelled phasor diagram of the circuit (5)

3.4 A single-phase inductive motor in a workshop is connected to a $230\ \text{V}$, $50\ \text{Hz}$ AC supply. The motor can be represented by a parallel RL circuit, where the resistive branch has a resistance of $920\ \Omega$ and the inductive branch has an inductive reactance of $184\ \Omega$.

To improve the efficiency of the installation, a capacitor is connected in parallel with the motor so that the power factor becomes unity.

Calculate the following:

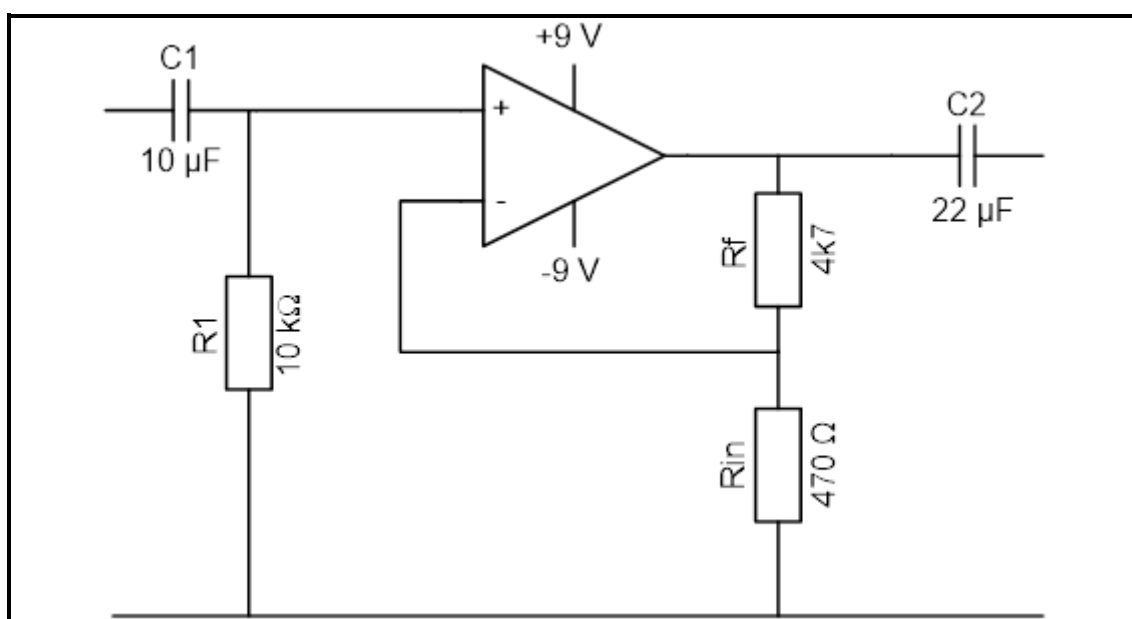
3.4.1 Capacitance required so that the power factor becomes unity (4)

3.4.2 Frequency at unity power factor (6)

[35]

QUESTION 4: SEMICONDUCTOR DEVICES

- 4.1 Compare the differences between a *bipolar junction transistor (BJT)* and a *field effect transistor (FET)* with reference to charge carriers and output control. (4)
- 4.2 With reference to MOSFET, name TWO modes of operation based on the construction of the MOSFET. (2)
- 4.3 Explain the concept *negative resistance* with reference to the operation of a UJT. (4)
- 4.4 Name ONE advantage of a Darlington pair. (1)
- 4.5 Name the THREE stages of the internal circuit of a 741 op amp IC. (3)
- 4.6 Name the THREE “Golden Rules” for an ideal op amp. (3)
- 4.7 Explain the importance of having a positive and negative supply on a 741 op amp IC. (2)
- 4.8 Name TWO advantages of negative feedback. (2)
- 4.9 FIGURE 4.9 below shows a non-inverting op amp circuit. Answer the questions that follow.

**FIGURE 4.9: NON-INVERTING OP AMP CIRCUIT**

- 4.9.1 Explain how you can prove that the circuit in FIGURE 4.9 is a non-inverting op amp. (2)
- 4.9.2 Calculate the gain of the circuit in FIGURE 4.9. (3)

4.10 The 555 timer basically consists of two primary building elements (blocks):

- (i) Two comparators
- (ii) One S/R flip-flop (set-reset flip-flop)

Explain the function of the S/R flip-flop in the 555 timer IC. (5)

4.11 Name pin 7 of the 555 timer IC. (1)

4.12 Pin 2 of the 555 timer IC is the trigger pin. It is an active low trigger. Explain the operation of an active low trigger. (4)

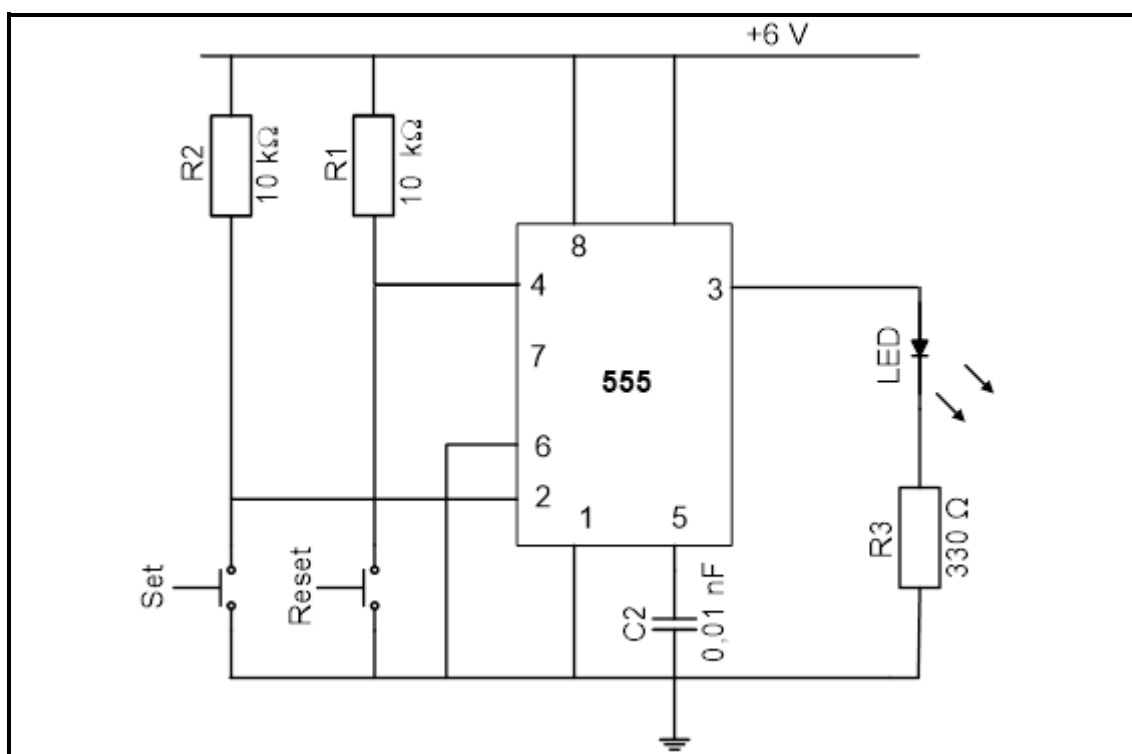
4.13 Explain the functional operation of a 555 timer IC. (6)

4.14 Name THREE modes the 555 timer IC can operate in. (3)

[45]

QUESTION 5: SWITCHING CIRCUITS

- 5.1 Give another name for a bistable multivibrator. (1)
- 5.2 Explain why bistable multivibrators are often referred to as the most basic building blocks for digital computer and processor systems. (2)
- 5.3 FIGURE 5.3 below shows a circuit diagram of a bistable multivibrator using a 555 op amp IC. Analyse the circuit and answer the questions that follow.

**FIGURE 5.3: 555 TIMER BISTABLE OP AMP**

- 5.3.1 What is the importance of having the resistor, R_3 , in the circuit connected to the LED? (1)
- 5.3.2 What would happen if the value of R_3 is changed to $47\ \Omega$? (2)
- 5.3.3 Explain the purpose of C_1 connected to pin 5 of the 555 IC. (1)
- 5.3.4 R_1 and R_2 are referred to as pull-up resistors. Explain the importance of these resistors in the circuit. (2)
- 5.3.5 With reference to the active low trigger used in the 555 IC, explain why we cannot use pull-down resistors in this circuit. (2)
- 5.4 Name ONE practical application of a bistable multivibrator circuit. (1)

- 5.5 FIGURE 5.5 shows a circuit of a monostable multivibrator making use of a 741 op-amp. Analyse the circuit and answer the questions that follow.

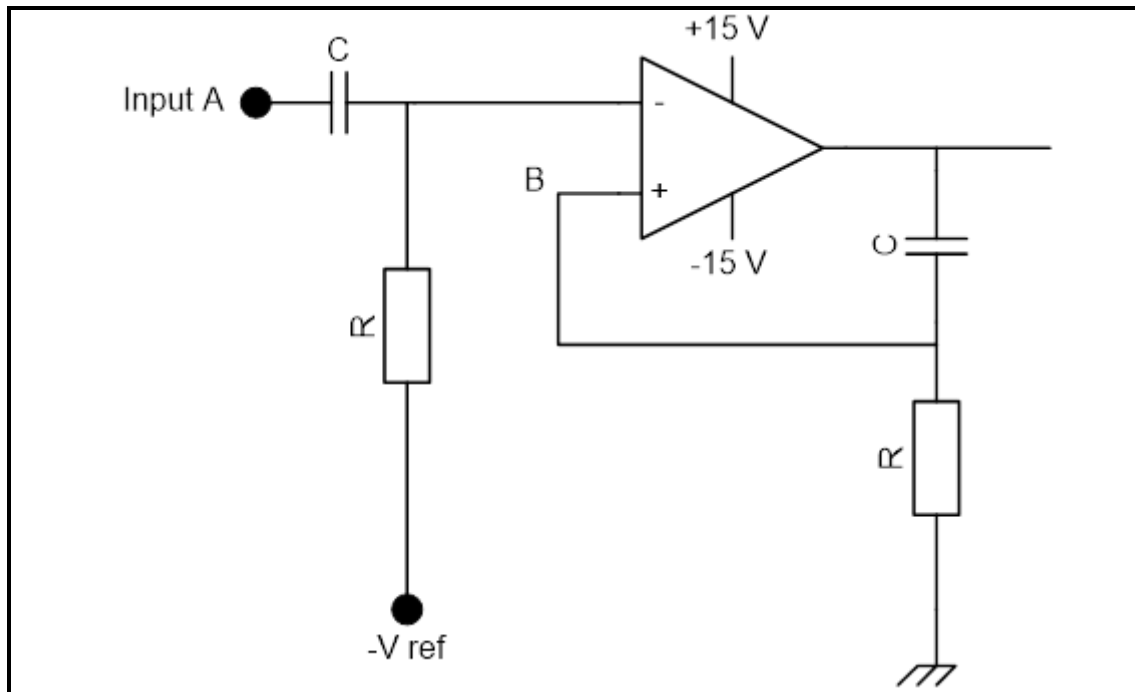


FIGURE 5.5: MONOSTABLE MULTIVIBRATOR USING 741 OP AMP

- 5.5.1 Explain the function of the components in FIGURE 5.5 labelled as **R** and **C**. (3)
- 5.5.2 Explain the THREE methods used to change the length of time the output signal would stay at HIGH. (3)
- 5.5.3 Explain the principle of operation of the monostable multivibrator in FIGURE 5.5. (6)
- 5.5.4 Name ONE practical application for the monostable multivibrator. (1)

- 5.6 FIGURE 5.6 shows a circuit diagram of a multivibrator. Analyse the circuit and answer the questions that follow.

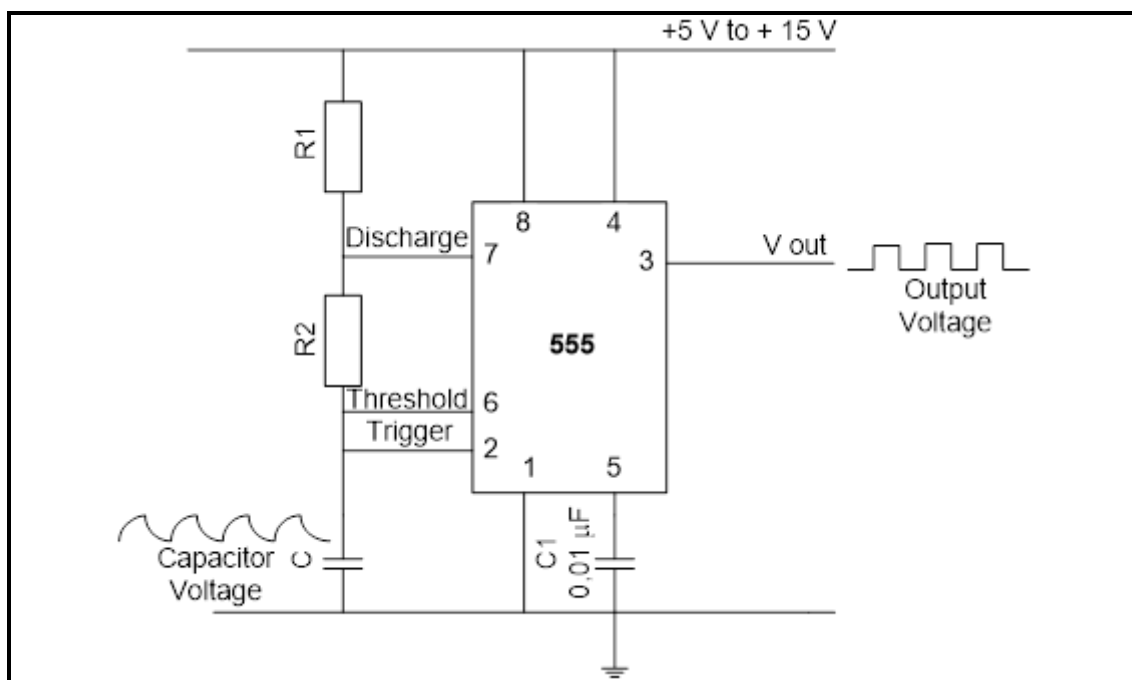


FIGURE 5.6: MULTIVIBRATOR CIRCUIT

- 5.6.1 Identify the multivibrator circuit shown in FIGURE 5.6. (1)
- 5.6.2 Explain the principle of operation of the circuit in FIGURE 5.6. (3)
- 5.6.3 Explain how the time period of the circuit can be changed. (1)
- 5.7 The Schmitt trigger works on the principle of hysteresis. Explain what *hysteresis* is. (2)
- 5.8 Draw the circuit symbol for a Schmitt trigger. (2)
- 5.9 Provide another name for positive feedback. (1)

5.10 FIGURE 5.10 shows an electronic circuit.

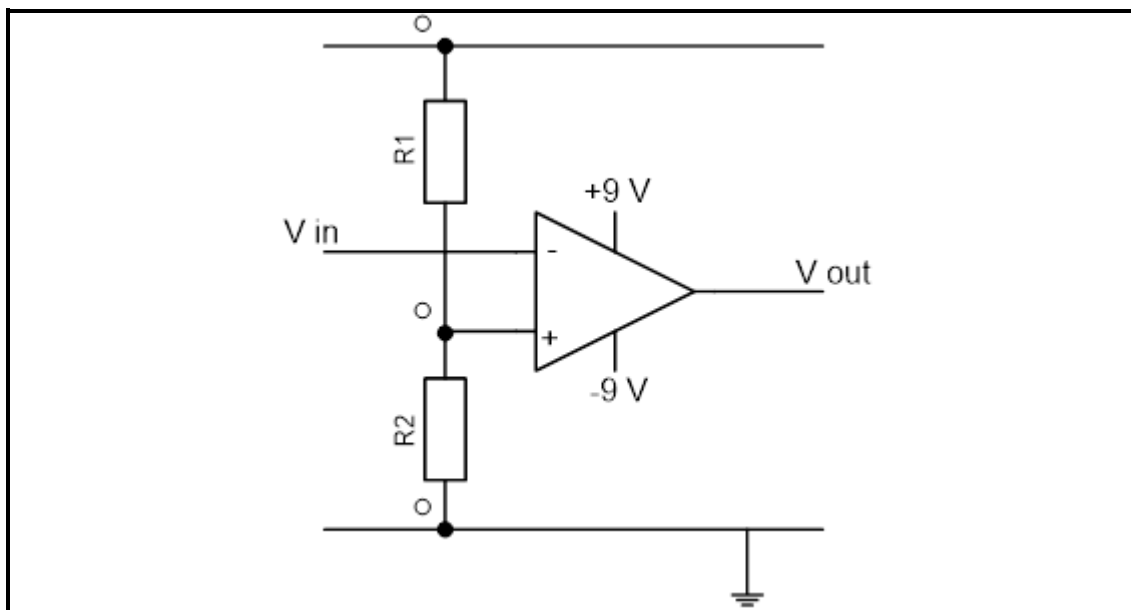


FIGURE 5.10: ELECTRONIC CIRCUIT

5.10.1 Identify the circuit in FIGURE 5.10. (1)

5.10.2 Describe the principle of operation for the circuit shown in FIGURE 5.10. (4)

5.10.3 Name TWO practical applications where the circuit in FIGURE 5.10 forms the basis of the application. (2)

5.11 FIGURE 5.11 shows the circuit diagram of a summing amplifier. Analyse the circuit and answer the questions that follow.

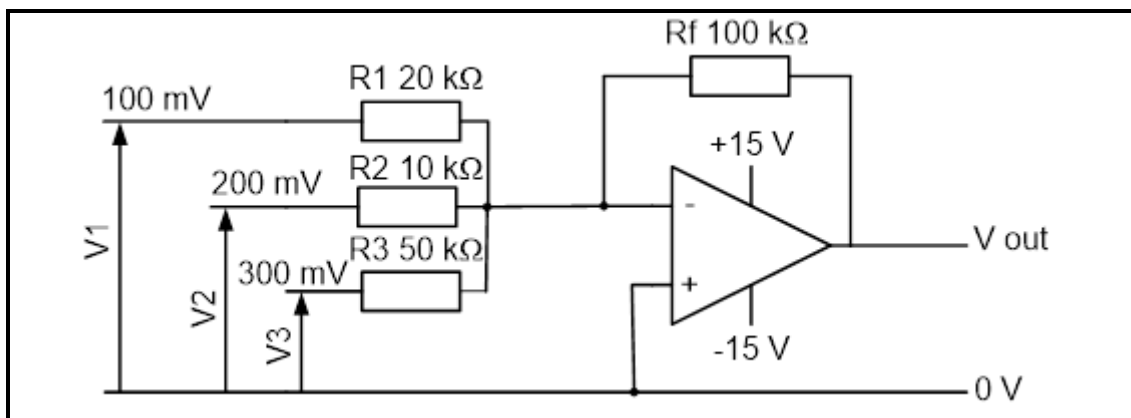


FIGURE 5.11: SUMMING AMPLIFIER

5.11.1 Explain why the circuit shown in FIGURE 5.11 is also referred to as a weighted summer or adder circuit. (2)

5.11.2 Name a practical application for the circuit shown in FIGURE 5.11. (1)

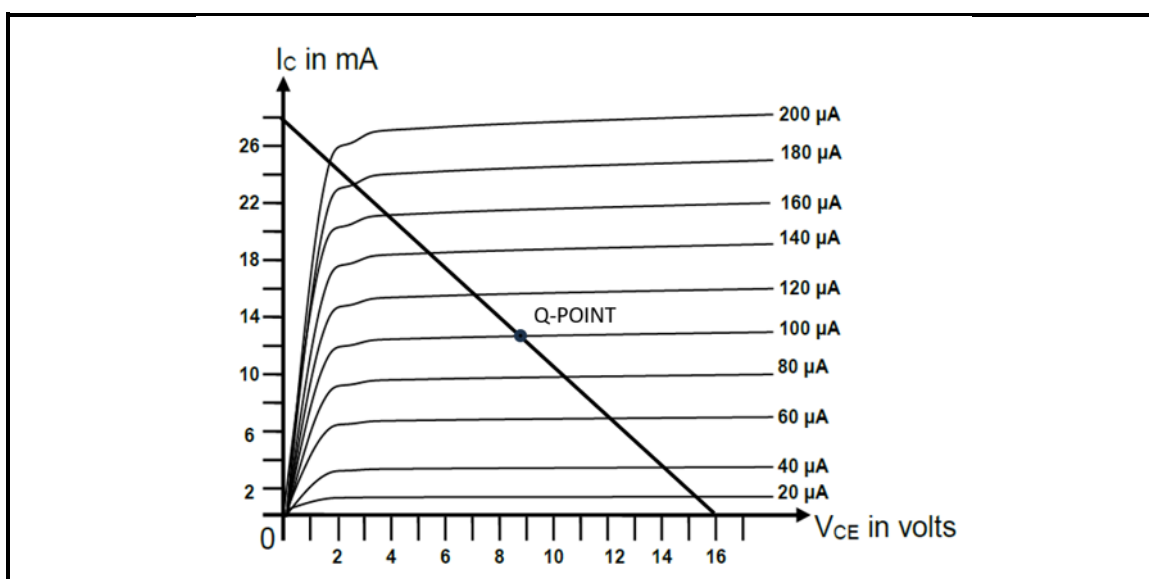
5.11.3 Calculate the output voltage of the circuit shown in FIGURE 5.11. Make use of the values provided in FIGURE 5.11. (3)

5.12 Draw a fully labelled circuit for the passive differentiator. (2)

[50]

QUESTION 6: AMPLIFIERS

- 6.1 Name the most used transistor amplifier circuit. (1)
- 6.2 Explain the concept of *bias* with reference to a transistor. (3)
- 6.3 Explain the meaning of the term *quiescent state*. (2)
- 6.4 Name the THREE characteristics that will be determined by the quiescent state of a transistor. (3)
- 6.5 Discuss the purpose of a load line with reference to transistor amplifiers. (2)
- 6.6 Discuss the TWO unwanted results from incorrect biasing with reference to transistor amplifiers. (4)
- 6.7 Explain what the effect will be on the load line if the supply voltage is increased. (4)
- 6.8 FIGURE 6.8 shows a load line plotted on an output characteristic curve for an amplifier. Answer the questions that follow.

**FIGURE 6.8: LOAD LINE AND OUTPUT CHARACTERISTICS**

- 6.8.1 Determine the maximum collector current (I_C) from FIGURE 6.8. (1)
- 6.8.2 Determine the voltage and current of the Q-point from FIGURE 6.8. (2)
- 6.8.3 Determine the collector-emitter voltage (V_{CE}) from FIGURE 6.8. (1)

- 6.9 FIGURE 6.9 shows the different characteristics of an amplifier. Analyse FIGURE 6.9 and answer the questions that follow.

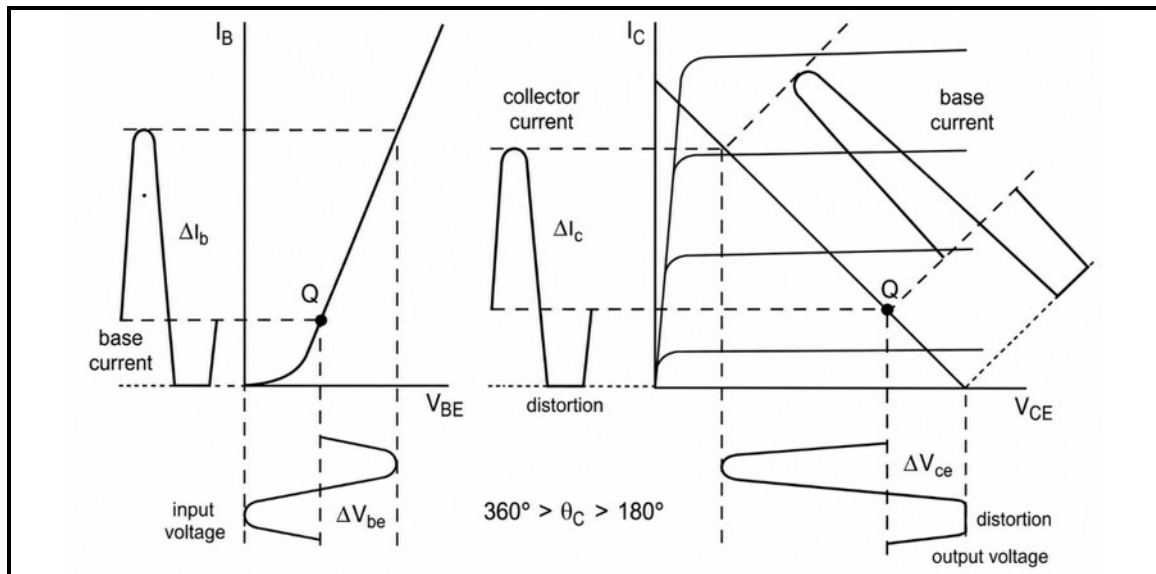


FIGURE 6.9: AMPLIFIER CHARACTERISTICS

- 6.9.1 Identify the class of amplifier shown in FIGURE 6.9. (1)
- 6.9.2 Determine the conduction angle for the amplifier shown in FIGURE 6.9. (2)
- 6.9.3 Name THREE advantages of this class of amplifier. (3)
- 6.10 Name TWO advantages of negative feedback. (2)
- 6.11 An amplifier has a 10 mW signal power input and 10 W signal power output. Calculate the amplifier's logarithmic gain ratio. (3)
- 6.12 Explain the principle of operation of a basic tank circuit as used in oscillator circuits. (6)
- 6.13 Explain why the output of a Hartley oscillator will be a sinusoidal wave. (1)
- 6.14 Draw a fully labelled circuit diagram of an RC shift oscillator. (4)

[45]

TOTAL: 200

FORMULA SHEET

RLC CIRCUITS

$$X_L = 2\pi fL \Omega \text{ and } X_C = \frac{1}{2\pi fC} \Omega$$

SERIES

$$I_T = I_R = I_C = I_L$$

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

$$V_T = \sqrt{V_R^2 + (V_L - V_C)^2} V$$

$$V_L = IX_L V, \quad V_C = IX_C V, \quad V_T = IZ V$$

$$\cos\theta = \frac{R}{Z} \text{ and } \cos\theta = \frac{V_R}{V_T}$$

$$Q = \frac{X_L}{Z} = \frac{X_C}{Z} = \frac{V_L}{V_S} = \frac{1}{R} \sqrt{\frac{L}{C}}$$

PARALLEL

$$V_T = V_R = V_L = V_C$$

$$I_R = \frac{V}{R} \text{ and } I_L = \frac{V}{X_L} \text{ and } I_C = \frac{V}{X_C}$$

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

$$\cos\theta = \frac{I_R}{I_T}$$

$$Q = \frac{X_L}{Z} = \frac{X_C}{Z} = \frac{V_L}{V_S} = \frac{1}{R} \sqrt{\frac{L}{C}}$$

SEMI-CONDUCTOR DEVICES

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

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

$$A_V = 1 + \frac{R_F}{R_{IN}}$$

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

$$\beta_{SUPER} = \beta_1 \times \beta_2$$

AMPLIFIERS

$$V_{CE} = V_{CC}$$

$$I_{Cmax} = \frac{V_{CC}}{R_C}$$

$$A' = \frac{A}{1 + \beta A}$$

$$\text{Power Gain } A_P = \log_{10} \left(\frac{P_{OUT}}{P_{IN}} \right)$$

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

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

$$F_0 = \frac{1}{2\pi\sqrt{L_T C}}$$

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

$$F_o = \frac{1}{2\pi\sqrt{6RC}}$$

SWITCHING CIRCUITS

$$\text{Gain } A_V = \frac{V_{\text{OUT}}}{V_{\text{IN}}} = -\left(\frac{R_f}{R_{\text{in}}}\right) \quad \text{inverting operational amplifier}$$

$$\text{Gain } A_V = \frac{V_{\text{OUT}}}{V_{\text{IN}}} = 1 + \left(\frac{R_f}{R_{\text{in}}}\right) \quad \text{non - nverting operational amplifier}$$

$$V_{\text{OUT}} = V_{\text{IN}} \times \left(-\frac{R_f}{R_{\text{in}}}\right) \quad \text{inverting operational amplifier}$$

$$V_{\text{OUT}} = -(V_1 + V_2 + V_3) \quad \text{summing up operational amplifier}$$

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

$$f = \frac{1}{2\pi\sqrt{6LC}}$$