



Province of the
EASTERN CAPE
EDUCATION

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NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2026

ELECTRICAL TECHNOLOGY: ELECTRONICS MARKING GUIDELINE

MARKS: 200

This marking guideline consists of 12 pages.

INSTRUCTIONS TO MARKERS

1. All calculations with multiple answers imply that any relevant, acceptable answer should be considered.
2. Calculations:
 - 2.1 All calculations must show the formulae.
 - 2.2 Substitution of values must be done correctly.
 - 2.3 All answers **MUST** contain the correct unit to be considered.
 - 2.4 Alternative methods must be considered, provided that the correct answer is obtained.
 - 2.5 Where an incorrect answer could be carried over to the next step, the first answer will be deemed incorrect. However, should the incorrect answer be carried over correctly, the marker has to re-calculate the values, using the incorrect answer from the first calculation. If correctly used, the candidate should receive the full marks for subsequent calculations.
 - 2.6 Markers should consider that learners answers may deviate slightly from the marking guideline depending on how and where in the calculation rounding off was used.
3. These marking guidelines are only a guide with model answers.
4. Alternative interpretations must be considered and marked on merit. However, this principle should be applied consistently throughout the marking session at ALL marking centres.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

- | | | |
|------|-----|-------------|
| 1.1 | B ✓ | (1) |
| 1.2 | A ✓ | (1) |
| 1.3 | A ✓ | (1) |
| 1.4 | A ✓ | (1) |
| 1.5 | C ✓ | (1) |
| 1.6 | D ✓ | (1) |
| 1.7 | C ✓ | (1) |
| 1.8 | D ✓ | (1) |
| 1.9 | C ✓ | (1) |
| 1.10 | C ✓ | (1) |
| 1.11 | A ✓ | (1) |
| 1.12 | D ✓ | (1) |
| 1.13 | B ✓ | (1) |
| 1.14 | D ✓ | (1) |
| 1.15 | B ✓ | (1) |
| | | [15] |

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

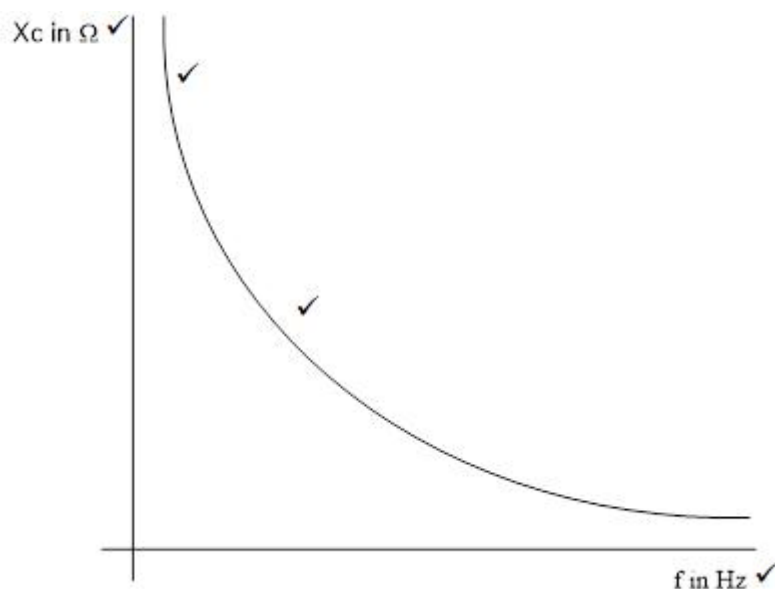
- | | | | |
|-----|-------|--|-----|
| 2.1 | 2.1.1 | The supervisor punishing or treating Sipho unfairly (giving unpleasant tasks or excluding him from training) after he reported unsafe practices. ✓ | (1) |
| | 2.1.2 | Victimisation occurs when a worker is treated unfairly or punished because they report unsafe, illegal, or unethical behaviour. ✓ | (1) |
| | 2.1.3 | Report the victimisation to higher management / the health and safety representative/union / follow formal grievance procedures. ✓ | (1) |
| 2.2 | | Unsafe acts are things done by people that are unsafe, ✓ while unsafe conditions are about the working conditions and not acts. ✓ | (2) |
| 2.3 | | Horseplay, ✓ running, not wearing PPE.
ANY relevant answer should be considered. | (1) |

- 2.4 2.4.1 Quantitative risk analysis is the process of evaluating risk using numerical values or measurements to determine the level of danger. ✓ (1)
- 2.4.2 Likelihood/probability of the hazard occurring. ✓
Severity of possible injury or damage.
Frequency of exposure to the hazard.
(Any ONE of the above is accepted as correct) (1)
- 2.4.3 Isolating or switching off the main power supply before repair work / ensuring the circuit is not live before working. ✓ (1)
- 2.5 Fire ✓
Cut
Fracture
Electrical shock
Bleeding
(Any ONE above or any other relevant answer) (1)
- [10]

QUESTION 3: RLC CIRCUITS

- 3.1 3.1.1 The inductive reactance of the circuit is higher ✓ than the capacitive reactance, ✓ thus the phase angle is leading. (2)
- 3.1.2 Although the ideal resonant circuit is meant to be resonant at only one frequency, ✓ in reality, this is not so, as there is a narrow band of frequencies on either side of the resonant point that have some appreciable effect on the circuit. This small band, centred around the resonant frequency f_r is called the bandwidth (BW). ✓ (2)

3.2



(4)

3.3 3.3.1 $X_L = \frac{V_L}{I_T} \Omega \checkmark$

$$X_L = \frac{4,21}{1,43} \checkmark$$

$$X_L = 2,94 \Omega \checkmark$$

(3)

3.3.2 $X_L = 2\pi fL \Omega \checkmark$

$$L = \frac{X_L}{2\pi f} H$$

$$L = \frac{2,94}{2\pi \times 50} H \checkmark$$

$$L = 9,36 \times 10^{-3} H \checkmark$$

(3)

3.3.3 $X_C = \frac{1}{2\pi fC} \Omega \checkmark$

$$X_C = \frac{1}{2 \times \pi \times 50 \times 68 \times 10^{-6}} \Omega$$

$$X_C = 46,81 \Omega \checkmark$$

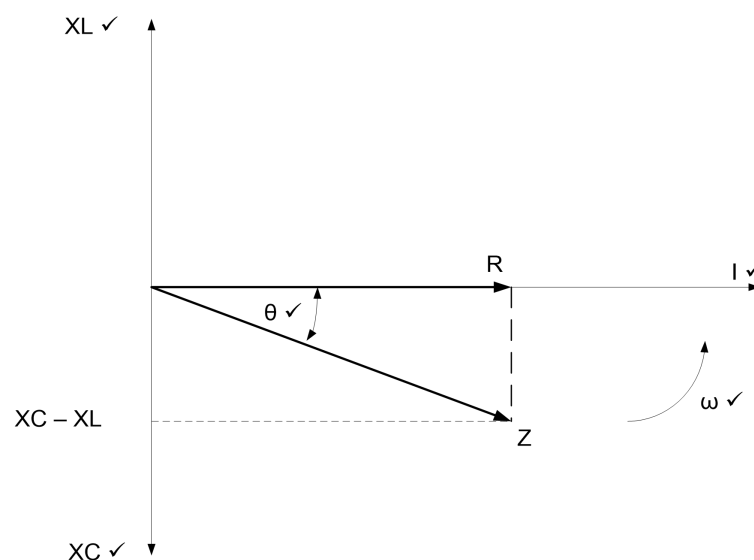
$$Z = \sqrt{R^2 + (X_C - X_L)^2} \Omega \checkmark$$

$$Z = \sqrt{47^2 + (46,81 - 2,94)^2} \Omega \checkmark$$

$$Z = 64,29 \Omega \checkmark$$

(6)

3.3.4



Direction of rotation and current as reference is compulsory for ONE mark each.

ANY THREE other CORRECT labels ONE mark each.

(5)

3.4 3.4.1 AT UNITY $X_L = X_C$ ✓

$$X_C = \frac{1}{2\pi f C} \Omega \quad \checkmark$$

$$C = \frac{1}{2\pi f X_C} F$$

$$C = \frac{1}{2\pi \times 50 \times 184} F \quad \checkmark$$

$$C = 17,3 \mu F \quad \checkmark$$

(4)

3.4.2 $X_L = 2\pi f L \Omega$ ✓

$$L = \frac{X_L}{2\pi f} F$$

$$L = \frac{184}{2\pi \times 50} H \quad \checkmark$$

$$L = 0,56 H \quad \checkmark$$

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

$$f_r = \frac{1}{2\pi\sqrt{0,56 \times 17,3 \times 10^{-6}}} Hz \quad \checkmark$$

$$f_r = 51,13 Hz \quad \checkmark$$

(6)

[35]

QUESTION 4: SEMICONDUCTOR DEVICES

4.1 Bipolar junction transistor makes use of both holes and electrons as charge carriers at the same time. ✓

Bipolar junction transistors are current controlled devices. ✓

Field effect transistors make use of only one charge carrier at a time, either holes or electrons. ✓

Field effect transistors are voltage-controlled devices. ✓

(4)

4.2 Depletion Mode ✓

Enhancement Mode ✓

(2)

4.3 As the UJT is triggered "on" ✓ current floods into the lower base region and as its resistance falls current through the bar rises. ✓ At the same time, the potential on the emitter is pulled down. ✓ This response is contrary to Ohm's law because the current through the emitter rises while its potential falls. ✓

(4)

- 4.4 The most important advantage of the Darlington pair is its high current gain. ✓
Another important feature is the circuits improved input impedance. This can be shown to be substantially increased, making it far less likely to 'load' any preceding stage of the circuit and so demand far less current to operate.
When used in the common collector form the Darlington pair also develops a very low output impedance.

(ANY ONE for 1 mark) (1)
- 4.5 Differential amplifier input stage. ✓
A second high-gain differential amplifier stage. ✓
Common collector (Darlington pair) output stage. ✓ (3)
- 4.6 The input terminals draw no current. ✓
The inputs are always at the same voltage, i.e.: there is no difference between them. ✓
The open loop gain of the device is infinite. ✓ (3)
- 4.7 Having a positive and negative supply rail for the 741 op amp, allows the output to rise above the 0 V position ✓ and fall below the 0 V position. ✓ (2)
- 4.8 The amplifier circuit's gain will be reduced. ✓
The amplifier becomes much more stable. ✓
The distortion of the output signal is reduced.
The range of frequencies that can be amplified is increased. (2)
- 4.9 4.9.1 The input ✓ is connected to the non-inverting (+) input pin. ✓ (2)
- 4.9.2 $A_V = 1 + \frac{R_f}{R_{in}}$ ✓
 $A_V = 1 + \frac{4k7}{470}$ ✓
 $A_V = 11$ ✓ (3)
- 4.10 A 'memory cell', storing the information it received last until new information is received. ✓ It has two stable states. ✓ When an input is received, it always changes state, from one state to the other. ✓ It has two input terminals that work opposite to each other. When the 'Set' input is activated, the flip-flop output goes 'high' ✓ and when the 'Reset' input is activated, the flip-flop output goes 'low'. ✓ (5)
- 4.11 Discharge Pin ✓ (1)

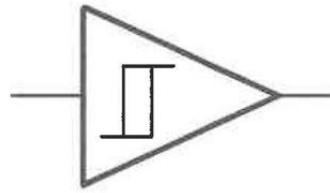
- 4.12 This pin acts like a starter pistol to set off the IC. ✓ It is an active low trigger. When the voltage on Pin 2 is less than $\frac{1}{3}$ of the supply voltage, the output goes 'high' ✓ and when the voltage rises above $\frac{2}{3}$ of the supply voltage, the output goes 'low'. ✓ If connected to ground, the output will go 'high' and remain 'high'. ✓ (4)
- 4.13 Three series-connected resistors of identical value ($5\text{ k}\Omega$) provide by voltage-division, ✓ two stepped down voltages of $\frac{2}{3}$ and $\frac{1}{3}$ of the supply voltage. ✓ The first comparator compares the upper voltage with the threshold voltage to trigger the 555 as the charging voltage reaches $\frac{2}{3}$ of the supply, ✓ while the lower voltage is compared against the trigger voltage by the second comparator. ✓
The outputs of the two comparators feed the flip-flop circuit, which sets its output accordingly, either 'high' or 'low'. When 'high', ✓ the output not only drives the output terminal but also causes the built-in transistor to saturate and form a low-resistance path for discharge current to flow from the discharge Pin 7 to ground. The second transistor is a PNP transistor that will only turn on when the Reset Pin 4 is connected to 0 V ground. When this happens the entire 555 timer operation is automatically reset. ✓ (6)
- 4.14 Astable ✓
Mono stable ✓
Bistable ✓ (3)
[45]

QUESTION 5: SWITCHING CIRCUITS

- 5.1 Flip-flop ✓ (1)
- 5.2 It is a basic storage element ✓ being able to store one bit of data. ✓ (2)
- 5.3 5.3.1 It limits the current flowing through the LED. ✓ (1)
- 5.3.2 The resistance is lower, which in turn allows more current to flow through the LED, ✓ causing it to blow. ✓ (2)
- 5.3.3 The capacitor connected to pin 5 will eliminate unwanted electrical noise caused by the 555 IC's operation. ✓ (1)
- 5.3.4 It keeps the voltage on pin 2 HIGH. ✓ If there were no pull-up resistors, the voltage on pin 2 would be floating between 0 V and the supply voltage. ✓ (2)
- 5.3.5 The active low trigger needs a constant voltage on it. When the voltage is lowered to ground, it would only switch. If we used pull-down resistors, the voltage would be 0V on pin 2 until it switched, ✓ which would have meant that the 555 would be providing a high output until it switched. ✓ (2)
- 5.4 This type of circuit is ideal for use in an automated situation where a device is required to run continually back and forth over the same path. ✓ (1)

- 5.5 5.5.1 These components form a timing circuit ✓ which determines the charge and discharge time of the circuit. ✓ This, in turn, determines how long the output stays high or on before returning to the stable state of low. ✓ (3)
- 5.5.2 Change the value of the resistor. ✓
Change the value of the capacitor. ✓
Change the value of both the resistor and the capacitor. ✓ (3)
- 5.5.3 When the circuit is in its natural 'resting' condition, a negative voltage of $-V_{ref}$ on the inverting input serves to hold the op amp's inverting input low. ✓ causing the op amp to saturate and its output rises to hold at $+15\text{ V}$. ✓ Capacitor C charges up with its top plate at $+15\text{ V}$ and its lower plate down to 0 V . Once C has charged, no current flows through resistor R as there is zero voltage across it. ✓ This then holds the non-inverting input terminal at 0 V . A positive trigger pulse greater than V_{ref} applied to the input terminal will raise the inverting input potential above the 0 V of the non-inverting input, causing the op amp to reverse its condition and saturate with its output switching to -15 V . ✓ A total change in output voltage of 30 V . At the switching point the capacitor already has a charge of $+15\text{ V}$ therefore its lower plate falls through a voltage of 30 V (from $+15\text{ V}$ to -15 V). ✓ As soon as this happens, the capacitor immediately begins discharging through resistor R. Its lower plate voltage gradually rises, heading towards 0 V . This rise continues until its voltage, which is also the voltage at the non-inverting input, is less negative than V_{ref} . At this point V_{out} then changes back to $+15\text{ V}$. ✓ (6)
- 5.5.4 It is used to eliminate switch bounce. ✓ (1)
- 5.6 5.6.1 Astable multivibrator ✓ (1)
- 5.6.2 This circuit is called astable because it has no stable state in which to rest. ✓ Its output continually oscillates between its two extreme maximums of $+V$ and $-V$. In this circuit both Trigger Pin 2 and Threshold Pin 6 are connected to the top of the timing capacitor. ✓ This allows the circuit to repeatedly re-trigger, becoming what is called a 'free-running' oscillator, producing a continual stream of 'high' – 'low' pulses at its output. ✓ (3)
- 5.6.3 By changing the value of the capacitor or the resistor forming the timing circuit. ✓ (1)
- 5.7 The time delay ✓ between cause and effect. ✓ (2)

5.8



One mark for the triangle, ✓ one mark for the hysteresis characteristic inside the triangle. ✓

(2)

5.9 Regenerative feedback ✓

(1)

5.10 5.10.1 Comparator ✓

(1)

5.10.2 When one of its two input voltages is higher than the other, ✓ the comparator circuit goes into one of its two saturation states ✓ and, when the inputs are reversed ✓ the comparator switches its output to its other saturation state. ✓

(4)

5.10.3 Dark sensor ✓
Temperature sensor ✓

(2)

5.11 5.11.1 All three of the input resistors and the feedback resistor ✓ have different values. ✓

(2)

5.11.2 Audio mixer ✓

(1)

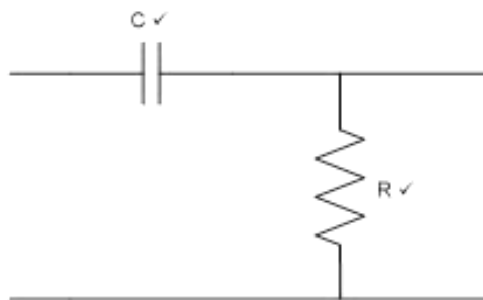
$$5.11.3 \quad V_{out} = - \left(V_1 \frac{R_f}{R_1} + V_2 \frac{R_f}{R_2} + V_3 \frac{R_f}{R_3} \right) V \quad \checkmark$$

$$V_{out} = - \left(100 \text{ mV} \frac{100k}{20k} + 200 \text{ mV} \frac{100k}{10k} + 300 \text{ mV} \frac{100k}{50k} \right) V \quad \checkmark$$

$$V_{out} = - 3,1 V \quad \checkmark$$

(3)

5.12



Both the positioning of the capacitor and the resistor must be correct for TWO marks.

(2)

[50]

QUESTION 6: AMPLIFIERS

- 6.1 Common Emitter Amplifier ✓ (1)
- 6.2 A transistor is said to be biased when its surrounding circuit sets up the correct, ✓ pre-chosen voltages at its terminals ✓ which in turn cause controlled and selected currents to flow through the circuit. ✓ (3)
- 6.3 Quiescent state is a fixed ✓ ready-state condition of the transistor. ✓ (2)
- 6.4 The maximum possible change in output current and voltage that the circuit can manage. ✓
The level of quiescent current I_{CQ} that will flow through the transistor. ✓
The quiescent terminal voltage V_{CEQ} . ✓ (3)
- 6.5 A circuit's operating capabilities ✓ and limitations are shown by a load line. ✓ (2)
- 6.6 Changes in either temperature or power supply voltage ✓ can cause the transistor's currents to change. This will shift the operating point. ✓
Any change in this point can distort the signal to be amplified. ✓
If a circuit is not correctly biased and stable, it could allow increases in currents leading to a thermal runaway situation, ✓ which could destroy the transistor. (4)
- 6.7 If the supply voltage rises, then the lower end point of the load line must shift outwards to the new voltage. ✓ This will have the effect of causing the Q point to also move outward, ✓ changing both the quiescent current I_{CQ} ✓ and voltage V_{EEQ} . The same will happen if the supply voltage falls. ✓ (4)
- 6.8 6.8.1 $I_{Cmax} = 28 \text{ mA}$ ✓ (1)
- 6.8.2 $V_q = 9 \text{ V}$ ✓
 $I_q = 12 \text{ mA}$ ✓ (2)
- 6.8.3 $V_{CE} = 16 \text{ V}$ ✓ (1)
- 6.9 6.9.1 Class AB amplifier ✓ (1)
- 6.9.2 Between 180° and 360° ✓ (1)
- 6.9.3 Each half circuit is able to amplify the input signal to double its previous greatest size. ✓
The circuit introduces little or no distortion as each half is biased in its linear region, improving the quality of the output signal. ✓
The circuit is almost as efficient as a pure Class B stage. ✓ (3)

- 6.10 Improving the amplifier's stability. ✓
 Increasing the amplifier's bandwidth. ✓
 Enhancing the amplifier's input and output impedances.
 Reducing or suppressing a noise produced within the amplifier. (It does not affect any noise created externally and introduced at the input terminals).

(Any TWO for TWO marks)

(2)

6.11 $A_p = \log_{10} \left(\frac{P_{out}}{P_{in}} \right) \text{ Bells}$ ✓

$$A_p = \log_{10} \left(\frac{10}{10 \times 10^{-3}} \right) \checkmark$$

$$A_p = 3 \text{ Bells} \checkmark$$

(3)

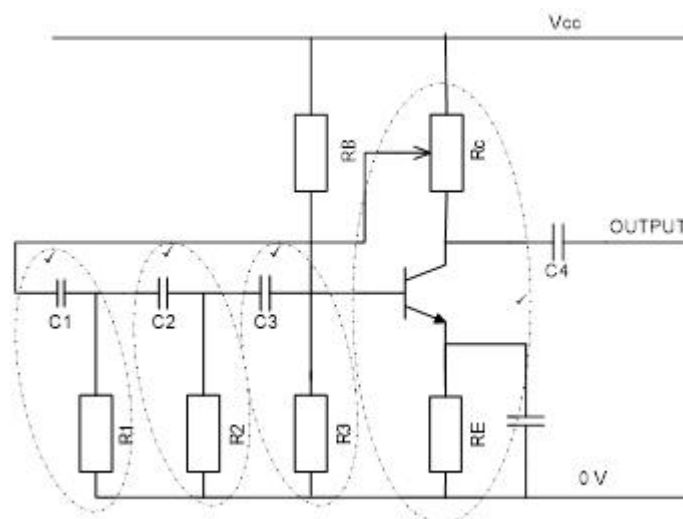
- 6.12 These circuits rely on the resonant properties of a parallel-connected inductor-capacitor LC combination commonly called a tank circuit. ✓
 When connected to a dc supply, the tank circuit begins to oscillate sinusoidally, first drawing a charge from the supply and then transferring it back and forth between its two components. ✓
 As dc power is applied to the circuit, the capacitor will immediately charge up. ✓
 Upon removing the dc supply, the capacitor discharges through the inductor. As it does, the capacitor transfers the electrostatic charge stored between its plates to the inductor, which, ✓ in turn, stores it in its magnetic field as an electromagnetic charge. ✓ As the inductor cannot save the charge, it immediately releases it back into the circuit as current, which recharges the capacitor. ✓

(6)

- 6.13 The Hartley oscillator is a sinusoidal oscillator. ✓

(1)

6.14



(4)

[45]

TOTAL: 200