Province of the
EASTERN CAPE
EDUCATION

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NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2025

ELECTRICAL TECHNOLOGY: ELECTRONICS MARKING GUIDELINE

MARKS: 200

This marking guideline consists of 11 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 D ✓ (1)

1.2 B ✓ (1)

1.3 A ✓ (1)

1.4 C ✓ (1)

1.5 B ✓ (1)

1.6 A ✓ (1)

1.7 C ✓ (1)

1.8 D ✓ (1)

1.9 A ✓ (1)

1.10 B ✓ (1)

1.11 D ✓ (1)

1.12 A ✓ (1)

1.13 B ✓ (1)

1.14 D ✓ (1)

1.15 B ✓ (1)

[15]

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

2.1 No employer shall:

- Dismiss an employee or reduce the rate of his/her renumeration. ✓
- Alter the terms and conditions of his/her employment to terms and conditions less favourable to him/herself.
- Alter his/her position relative to other employees employed by that employer to his/her disadvantage. (1)

2.2 When we cannot see clearly due to poor lighting, we are at risk of making mistakes ✓ which could lead to injury, damage or even death. ✓ (2)

2.3 Any source of potential damage, ✓ harm or adverse health effects on something or someone. ✓ (2)

2.4 Human rights ensure that your human dignity is not infringed, ✓ that you are treated with dignity and respect ✓ and not exploited. ✓ (3)

2.5 Protect yourself from electrical shock by not touching the person. ✓
Remove the victim from the source of the electrical shock by using a non-conductive stick or something similar. ✓
Switch of the main supply.
Apply the necessary first aid.
Call for medical assistance. (2)

[10]

QUESTION 3: RLC CIRCUITS

3.1 3.1.1 The resistance that a pure inductor provides ✓ against the flow of alternating current (AC) in a circuit. ✓ (2)

3.1.2 The total combined resistance against the flow of AC current ✓ in a circuit consisting of a resistor, capacitor and inductor. ✓ (2)

3.2 The capacitive reactance will increase ✓ as the frequency is indirectly ✓ (inversely) proportional to the capacitance. ✓ (3)

3.3 During series resonance, $X_L = X_C$. ✓
Therefore Z = R ✓
This means the resistance of the circuit will be at its lowest. ✓
Therefore, according to Ohm's law, the current will be at its maximum. ✓ (4)

3.4 3.4.1 $X_C = \frac{1}{2\pi f C}\ \Omega$

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

$C = \frac{1}{2 \times \pi \times 50 \times 12{,}67}\ \mu F$ ✓

$C = 251{,}2\ \mu F$ ✓ (3)

3.4.2 $X_L = 2\pi f L\ \Omega$ ✓

$X_L = 2\pi \times 50 \times 2\ \Omega$ ✓

$X_L = 628{,}32\ \Omega$ ✓

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

$Z = \sqrt{30^2 + (628{,}32 - 12{,}67)^2}\ \Omega$ ✓

$Z = 616{,}38\ \Omega$ ✓ (6)

3.4.3 $f_r = \frac{1}{2\pi\sqrt{LC}}\ Hz$ ✓

$f_r = \frac{1}{2\pi\sqrt{7 \times 10^{-3} \times 251{,}2 \times 10^{-6}}}\ Hz$ ✓

$f_r = 120{,}05\ Hz$ ✓ (3)

3.4.4 $I_{f_r} = \frac{V_T}{R}\ A$ ✓

$I_{f_r} = \frac{225}{30}\ A$ ✓

$I_{f_r} = 7{,}5\ A$ ✓ (3)

3.5 3.5.1 $I_R = \frac{V_T}{R}\ A$ ✓

$I_R = \frac{420}{470}\ A$

$I_R = 0,$ ✓$89\ A$ (2)

3.5.2 $I_L = \frac{V_T}{X_L}\ A$ ✓

$I_L = \frac{420}{264}\ A$

$I_L = 1,59\ A$ ✓ (2)

3.5.3 $I_C = \frac{V_T}{X_C}\ A$ ✓

$I_C = \frac{420}{310}\ A$

$I_C = 1,35\ A$ ✓ (2)

3.5.4 $X_L = 2\pi f L\ \Omega$ ✓

$264 = 2\pi 60 \times L$ ✓

$L = 0,7\ \text{H}$ ✓ (3)

[35]

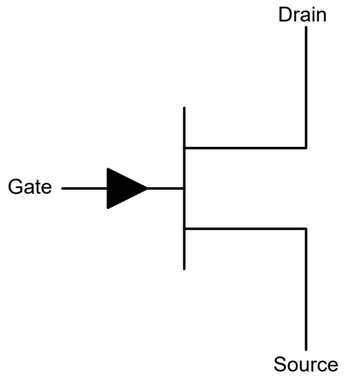
QUESTION 4: SEMICONDUCTOR DEVICES

4.1 Bipolar junction transistor ✓ (1)

4.2 Bipolar junction transistor is a current controlled device ✓ where a field effect transistor is a voltage-controlled device. ✓ (2)

4.3 4.3.1 field-effect transistor (FET) ✓ (1)

4.3.2



✓ (x 3) Per correct label

✓ (x 1) Drawing correct (4)

4.3.3
- The source and drain is connected to a supply voltage (V_{SD}) ✓
- The drain is connected to the positive and the source is connected to the negative. ✓
- The top and bottom of the channel is treated with an oppositely doped material to form a p-type area. ✓
- This area is now across the entire length of the channel and forms a clamping effect. ✓
- The clamping effect is enhanced by adding another voltage, V_{HB}, across the source and the gate. ✓
- The negative is connected to the gate and the positive is connected to the source. ✓
- This forms a pn-junction in the middle of the channel, between the n-Type channel and the p-type gate. ✓
- As with a reversed biased junction, a depletion region is formed. ✓
- With any change in the voltages over the terminals of the FET, the current flow to the output (drain) is controlled. ✓ (9)

4.3.4 When the gate voltage, V_{HB}, is set to 0V, ✓ and the source-drain voltage increases the drain current will react linearly. ✓ The drain current will rise sharply to the point where the channel cannot conduct current anymore. ✓ (3)

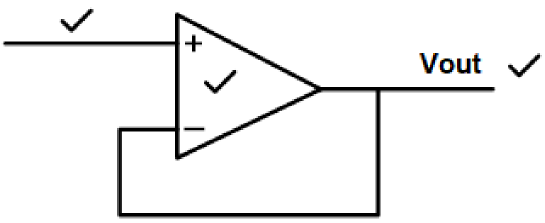
4.4 The second high gain differential amplifier detects the output of the first differential amplifier, ✓ compare the outputs, ✓ and amplifies the difference. ✓ (3)

4.5 $V_{OUT} = V_{IN}\left(1+\frac{R_f}{R_{in}}\right)V$ ✓

$6{,}9\ V = 17 \times 10^{-3}\left(1+\frac{R_f}{120}\right)$ ✓

$R_f = 48586\ \Omega$ ✓ (3)

4.6



(3)

4.7 Basic timing ✓
Flashing warning lights
Pulse generation, oscillations and waveforms
Digital logic testers
Creating musical notes
Industrial applications such as temperature measuring and positioning of servos (1)

4.8 A large circuit ✓ build on a single chip. ✓ (2)

4.9 This pin monitors the voltage ✓ across the timing capacitor where pin is been discharged. ✓ It sets the voltage level at which the trigger must be activated. ✓ (3)

4.10
- Three identical 5 kΩ resistors are connected in series to divide the voltage. ✓
- The voltage is divided into $\frac{2}{3}$ and $\frac{1}{3}$. ✓
- The first voltage is compared by the first comparator with the threshold voltage and activates the trigger as soon as the voltage reaches $\frac{2}{3}$ of the charging voltage. ✓
- At the same time the second comparator compares the bottom voltage with the trigger voltage. ✓
- The output of the two comparators therefore determines the output of the flip-flop circuit, which determines the output state of the IC. ✓ (5)

4.11 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. ✓
When the voltage on pin 2 is larger than $\frac{2}{3}$ of the supply voltage, ✓ the output will immediately go low. ✓ (5)

[45]

QUESTION 5: SWITCHING CIRCUITS

5.1 Bistable mode ✓
Monostable mode ✓
Astable mode ✓ (3)

5.2 The bistable multivibrator 555 circuit is ideal to be used in automated applications ✓ where an appliance must move forward and backwards continuously over the same track. ✓ Two pressure switches are used at each end of the track. ✓ When the appliance then pushes the switches, it will either set or reset the multivibrator. ✓ (4)

5.3 The timing capacitor ✓ and timing resistor ✓ (2)

5.4
- When the circuit is in resting state, a negative voltage ($-V_{REF}$) on the inverting input keeps the inverting input at low. ✓
- This saturates the op amp, and the output rises to and stays at +15V. ✓
- The timing capacitor starts to charge until it is fully charged, at which point no further current flow will be through the timing resistor. This keeps the non-inverting terminal to 0V. ✓
- A positive trigger pulse higher than the reference voltage on the inverting input terminal will ensure the voltage on the inverting terminal is higher than the 0V on the non-inverting terminal. ✓
- This causes the op amp to change its state and become saturated with an output of -15V. ✓
- The capacitor will now start to discharge until the voltage is less negative than $-V_{REF}$. When this happens, the output will saturate to +15V again. ✓ (6)

5.5
- The trigger pin, pin 2, is connected to the supply voltage by means of a pull-up resistor. ✓
- This resistor will keep pin 2 at a high. ✓
- The trigger is an active low trigger. ✓
- When the voltage on the trigger pin is less than $\frac{1}{3}$ of the supply voltage the output goes high. ✓
- When the voltage on the trigger pin is more than $\frac{2}{3}$ of the supply voltage the output goes low. ✓
- If the trigger pin is earthed (grounded), the output will go high and stay high. ✓ (6)

5.6 Free running refers to a signal which is constantly changing ✓ from a high to a low. ✓ It generates a continuous train ✓ of square pulses. ✓ (4)

5.7 5.7.1 $V_{out} = -\left(V_1\frac{R_f}{R_1} + V_2\frac{R_f}{R_2} + V_3\frac{R_f}{R_3}\right)\ V$ ✓

$320\ mV = -\left(1\ V\frac{R_f}{2k2} + 1{,}6\ V\frac{R_f}{1k7} + 2{,}7\ V\frac{R_f}{1\ k\Omega}\right)\ V$ ✓

$\frac{V_{OUT}}{R_f} = -\left(\frac{1}{2k2} + \frac{1{,}6}{1k7} + \frac{2{,}7}{1k}\right)\ V$

$R_f = \frac{320\ mV}{4{,}09\times10^{-3}}\ \Omega$

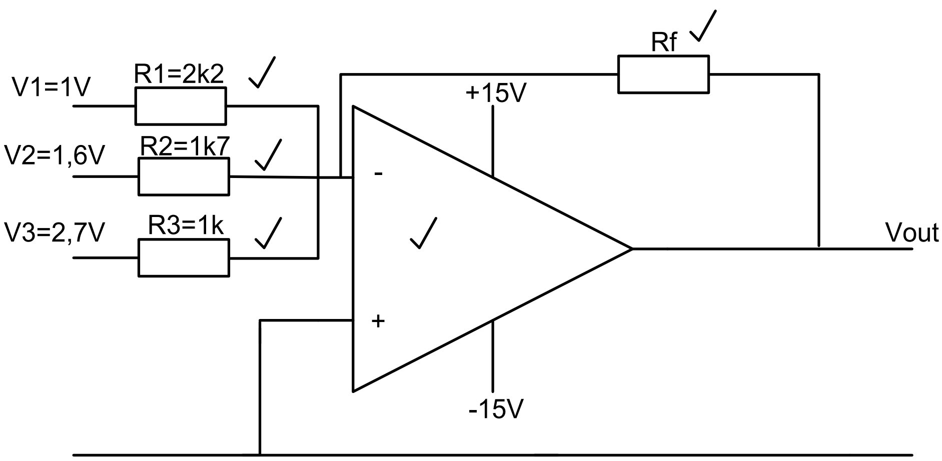
$R_f = 78{,}24\ \Omega$ ✓ (3)

5.7.2 $A_{v_1} = -(\frac{R_f}{R_1})$ ✓

$A_{v_1} = -(\frac{78{,}24}{2200})$ ✓

$A_{v_1} = -0{,}036$ ✓ (3)

5.7.3



(5)

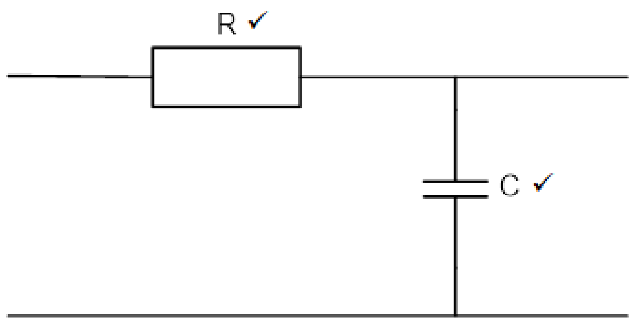
5.7.4 The inputs are connected to the inverting input pin of the op amp, ✓ hence the output will be 180 degrees out of phase with the input. ✓ (2)

5.8 Summing amplifiers are often used in mixers for musical instruments. ✓ (1)

5.9 When the feedback resistor ✓ and the input resistors are all the same value, ✓ it cancels out leaving you with the formula to use. (2)

5.10
- A thermistor is connected in series with a 5k6 resistor. ✓
- This sets the inverting input voltage. ✓
- The non-inverting input is connected to a voltage divider circuit, by been connected to two 5k6 resistors in series and a 10k potentiometer. ✓
- At low temperature the resistance of the thermistor is high, causing the voltage on the inverting input to be low. This causes the output to go high. ✓
- When the temperature increases the resistance of the thermistor will lower. ✓
- When the voltage on the inverting input is lower than the voltage on the non-inverting input, the output will go low. ✓ (6)

5.11



(2)
[50]

QUESTION 6: AMPLIFIERS

6.1 A small signal amplifier is used to amplify a very small current or voltage signal to a level which is easier to handle. ✓
A power amplifier is used to amplify the already amplified signal at its input to a higher level which could drive a speaker. ✓ (2)

6.2 6.2.1

$$I_C = \frac{V_{CC}}{R_C}\ A \ ✓$$

$$I_C = \frac{12}{800}\ A \ ✓$$

$$I_C = 0{,}015\ A \ ✓$$

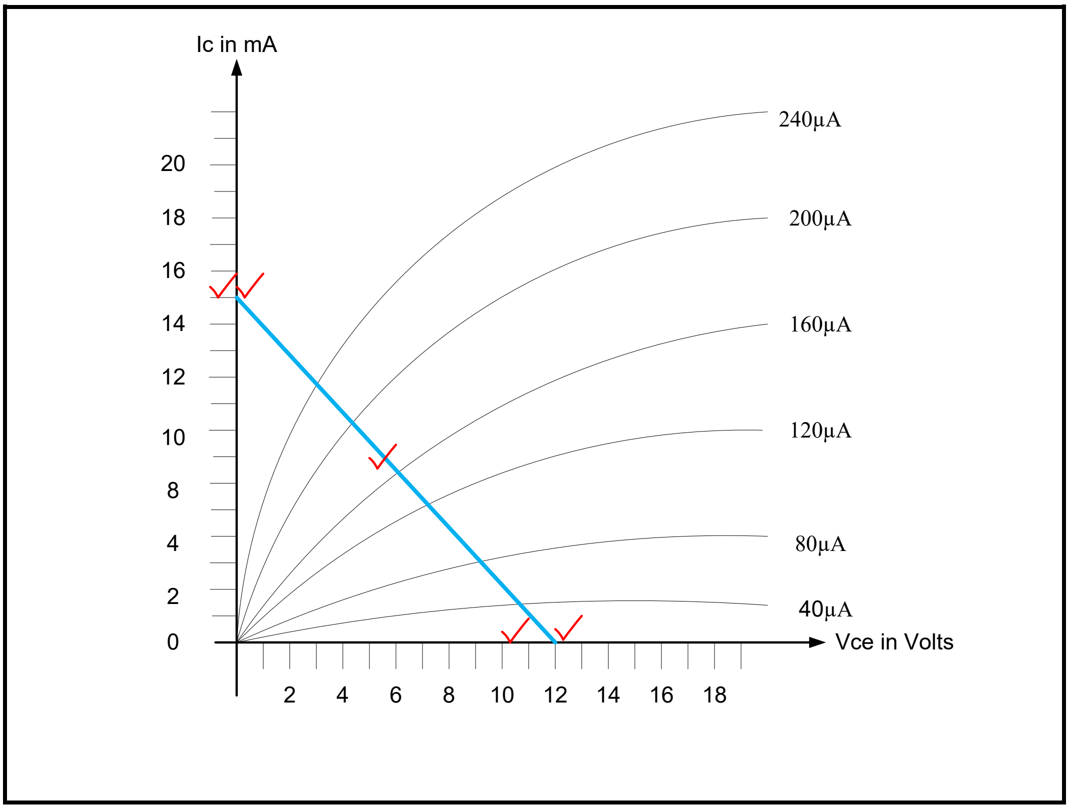
$$I_C = 15\ mA$$ (3)

6.2.2

$$V_{R_C} = V_{CC} \ ✓$$

$$V_{R_C} = 12\ V \ ✓$$ (2)

6.2.3



(5)

6.2.4 $I_C = \frac{V_{CC}}{R_C}\ A$ ✓

$I_C = \frac{15}{800}\ A$

$I_C = 0{,}0188\ A$ ✓

$I_C = 18{,}8\ mA$

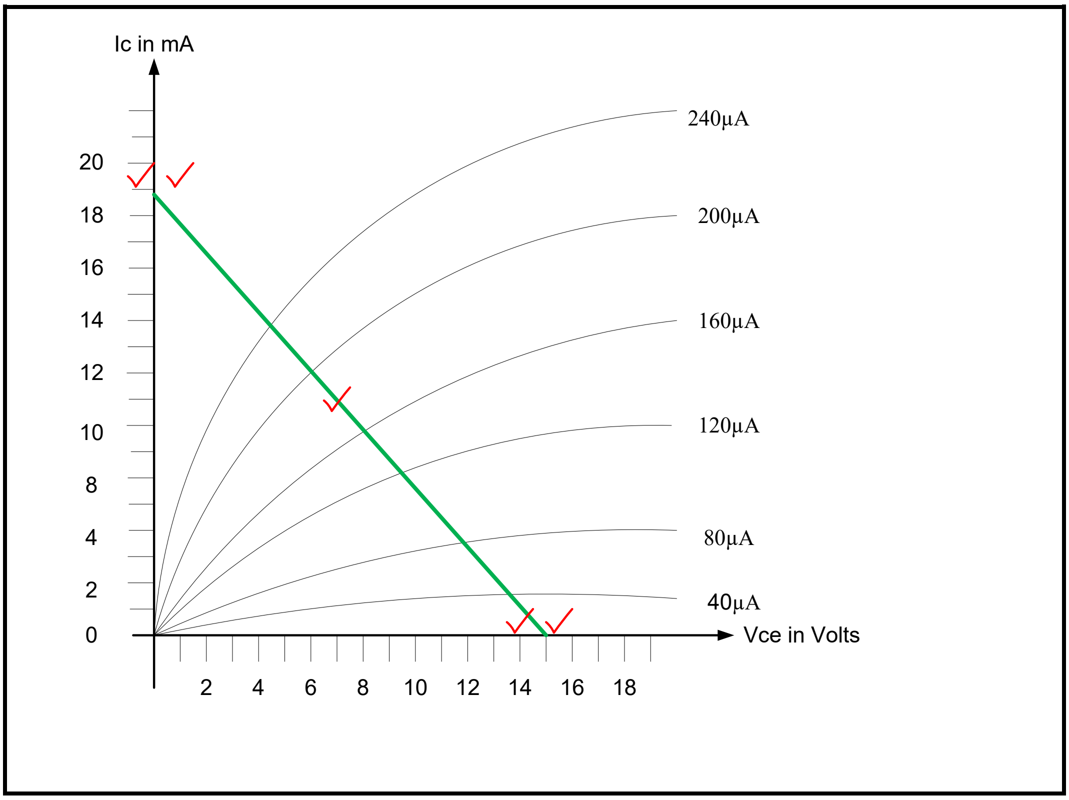
$V_{R_C} = V_{CC}$ ✓

$V_{R_C} = 15\ V$ ✓

- Collector current will increase. ✓
- Collector voltage will increase. ✓
- Load line will move to the right, but parallel to the previous load line. ✓

Q – Point will move to the right. ✓ (8)

6.2.5



(5)

6.3 6.3.1 Class A conduction angle is 360° ✓as the Q point is in the centre. ✓
Class B conduction angle is 180° ✓ as the Q point is at the cutoff point. ✓ (4)

6.3.2 Class A amplifiers only have a 25% efficiency due to heat loss. ✓
Class B amplifiers have a 50% efficiency as it only conducts for 50% of the cycle. ✓ (2)

6.4 It only amplifies one half of the signal, ✓ thus it is not able to amplify an audio signal successfully. ✓
As the transistor is forward biased in its cutoff area, ✓ the first 0,6 V of any input must first overcome the emitter-base junction before it can start to amplify the signal. ✓ (4)

6.5 Half point is the dB value ✓ expressed where the output power ✓ is either half ✓ or double ✓ the value of the original input power. (4)

6.6 The Hartley oscillator has a tank circuit which consists of two capacitors connected in series ✓ with each other, and both connected in parallel with an inductor. ✓
The Colpitts oscillator has a tank circuit which consists of two inductors connected in series ✓ with each other, and both connected in parallel with a capacitor. ✓ (4)
[45]

TOTAL: 200