



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

28 November 2023

This marking guideline consists of 7 pages.

QUESTION 1

1.1 According to Ohm's law:

$$R_P = \frac{R_L R_2}{R_L + R_2} = \frac{6,5}{6 + 5} = 2,727 \Omega \checkmark \checkmark$$

$$V_P = \frac{R_P}{R_T} \times V_T = \frac{2,727}{6,727} \times 10 = 4,054 V \checkmark \quad (5)$$

$$I_{RL} = \frac{V_P}{R_L} = \frac{4,054}{6} = 0,676 A \checkmark \checkmark$$

1.2 According to Thevenin's theorem:

$$V_{TH} = V_{AB} = \frac{R_2}{R_T} \times V_T = \frac{5}{9} \times 10 = 5,556 V \checkmark \checkmark$$

$$R_{TH} = \frac{R_1 R_2}{R_1 + R_2} = \frac{4,5}{4 + 5} = 2,222 \Omega \checkmark \checkmark$$

$$I_{RL} = \frac{V_{TH}}{R_T} = \frac{5,556}{8,222} = 0,676 A \checkmark \checkmark$$

(6)
[11]**QUESTION 2**

2.1 $Z_1 = 23 + j18 = 29,209 \angle 38,047$

$Z_2 = 40 - j31 = 50,606 \angle -37,776$

$Z_3 = 55 + j30 = 62,65 \angle 28,61$

$Z_S = 23 + j18 + 40 - j31 = 63 - j13 = 64,327 \angle -11,66 \checkmark$

$Z_4 = 20 - j45$

$$Z_P = \frac{Z_S \times Z_3}{Z_S + Z_3} = \frac{64,327 \angle -11,66 \times 62,65 \angle 28,61}{63 - j13 + 55 + j30} = \frac{4030,087 \angle -16,95}{118 + j17} \checkmark \checkmark \checkmark$$

$$= \frac{4030,087 \angle -16,95}{119,218 \angle 8,198} = 33,804 \angle -25,148 = 30,6 - j14,365 \checkmark \checkmark$$

$$Z_T = 30,6 - j14,365 + 20 - j45 = 50,6 - j59,365 = 78,003 \angle -49,56 \Omega \checkmark \checkmark \quad (8)$$

2.2 2.2.1 The ability of an inductor to oppose a change in current

2.2.2 The quality factor of a circuit or component at resonant frequency
OR
The ratio of the reactance of the inductor or capacitor to its equivalent resistance

2.2.3 The phasor sum of the reactances and the resistance

2.2.4 The angle between the applied voltage and the circuit current

2.2.5 When the reactances X_L and X_C are equal

(5 × 1) (5)

2.3

2.3.1

$$X_L = X_C$$

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

$$\therefore C = \frac{1}{4\pi^2 f^2 L} \checkmark$$

$$= \frac{1}{4 \times \pi^2 \times 50^2 \times 0,127} \checkmark$$

$$= 79,780 \mu F \checkmark$$

(3)

2.3.2 At resonance: $Z = R$

$$\therefore I = \frac{V}{R} = \frac{250}{250} = 1A \checkmark$$

$$\text{Now } X_L = 2\pi fL = 2 \times \pi \times 50 \times 0,127 = 39,898 \Omega$$

$$\therefore V_C = V_L = IX_L = 1 \times 39,898 = 39,898 V \checkmark$$

(2)

[18]

QUESTION 3

3.1

3.1.1

The positive side attracts electrons from the N-type material and the negative side attracts holes from the P-type material.

3.1.2

Generated by thermal or other means and also act as charge carriers; also known as minority charge carriers

(2 × 2) (4)

3.2

3.2.1

B

3.2.2

B

3.2.3

A

3.2.4

D

3.2.5

C

(5 × 1) (5)

[9]

QUESTION 4

- 4.1 4.1.1 True
 4.1.2 False
 4.1.3 True
 4.1.4 False
 4.1.5 True

(5 × 1) (5)

4.2 4.2.1 $V_{DC} = V_m - \frac{I_{DC}}{2fc} = 17 - \frac{20 \times 10^{-3}}{2 \times 50 \times 35 \times 10^{-6}} = 11,286 \text{ V}$

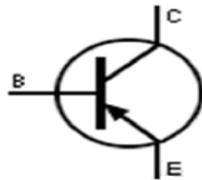
4.2.2 $V_{r(RMS)} = \frac{I_{DC}}{2 \times \sqrt{3} \times f \times C} = \frac{20 \times 10^{-3}}{2 \times \sqrt{3} \times 50 \times 35 \times 10^{-6}} = 3,333 \text{ V}$

4.2.3 $\%r = \frac{V_{r(RMS)}}{V_{DC}} \times 100 = \frac{3,333}{11,286} \times 100 = 29,51\%$

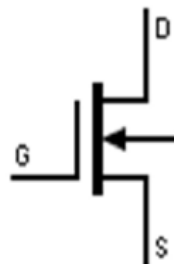
(3 × 2) (6)
[11]**QUESTION 5**

- 5.1 By applying a small forward bias to the base of the transistors (1)

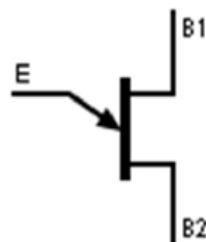
- 5.2 5.2.1



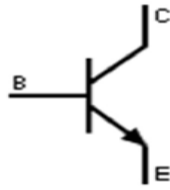
- 5.2.2



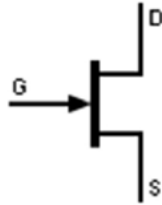
- 5.2.3



5.2.4



5.2.5



(5 × 1) (5)

5.3 5.3.1

$$A_p = 10 \log \frac{P_{out}}{P_{in}}$$

$$= 10 \log \frac{500}{500 \times 10^{-3}} \checkmark$$

$$= 30 \text{ dB} \checkmark$$

(2)

5.3.2

$$A_v = 20 \log \frac{V_{out}}{V_{in}} \quad \text{but} \quad V_O = \sqrt{P_O R_O}$$

$$= 20 \log \frac{70,717}{10} \checkmark$$

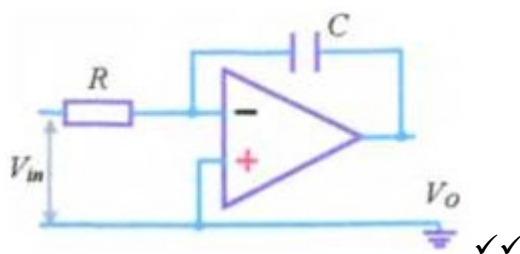
$$= 16,99 \text{ dB} \checkmark$$

$$= \sqrt{500 \times 10} \checkmark$$

$$= 70,717 \checkmark$$

(4)
[12]**QUESTION 6**

6.1



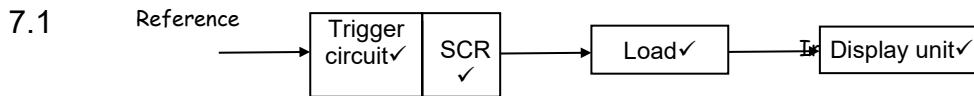
(2)

6.2 To reduce the gain of the amplifier to the required level

(1)

$$6.3 \quad V_O = \left(1 + \frac{R_f}{R_{in}}\right) V_{in} \checkmark = \left(1 + \frac{15 \times 10^3}{1,2 \times 10^3}\right) \times 4 \checkmark = 54 \text{ V} \checkmark$$

(3)
[06]

QUESTION 7

(4)

- 7.2
- When the core is in the centre of L1 and L2, the induced voltage in the secondary coil will be zero and there is no output.
 - When the core moves either up or down, there will be more induced voltage in that secondary coil.
 - The magnitude of the output voltage is proportional to the core displacement.

(3)

- 7.3 It allows only positive pulses to the gate of an SCR and prevents negative pulses from going to the gate.

(2)

[9]**QUESTION 8**

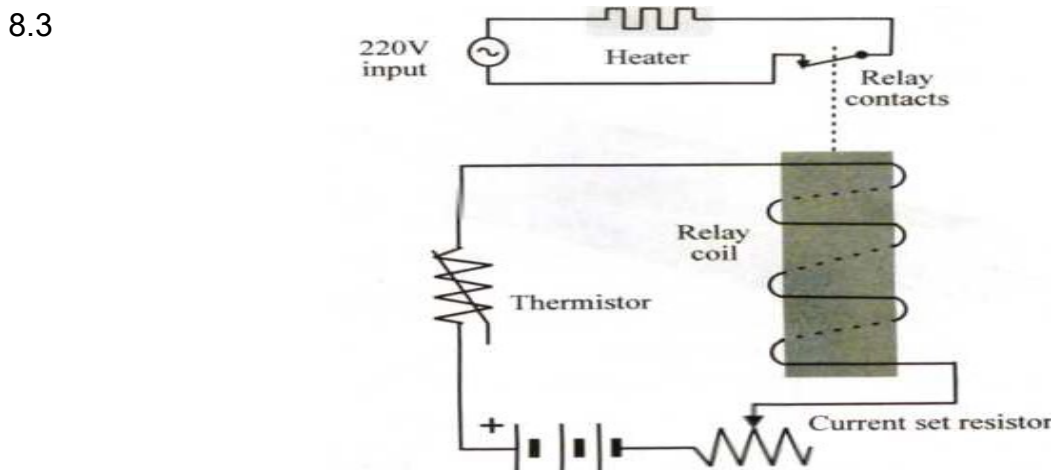
- 8.1
- The area of the plates
 - The distance between the plates
 - The insulating material between the plates

(3)

- 8.2
- 8.2.1 Motorcar tachometer system
- 8.2.2 Indicators

(2 × 1)

(2)



✓✓✓✓✓

(5)

[10]

QUESTION 9

- 9.1 It causes the display to drift across the screen, making measurement difficult (2)
- 9.2 A – Heater
B – Control grid
C – Accelerating anode
D – Converging beam
E – Diverging beam (5)
- 9.3
- Timing circuit for electronic applications
 - Audio frequency generation
 - Scanning circuits in an oscilloscope (3)
- 9.4
- 9.4.1 $V_P = 2,9 \times 0,6 = 1,74 \text{ V} \checkmark \checkmark$
- 9.4.2 $V_{\text{rms}} = 0,707 \times 1,74 = 1,23 \text{ V} \checkmark$
 $V_{\text{ave}} = 0,637 \times 1,74 = 1,108 \text{ V} \checkmark$
- (2 × 2) (4)
[14]
- TOTAL: 100**