



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N6

5 April 2024

This marking guideline consists of 8 pages.

QUESTION 1

1.1 1.1.1 $V_C @ t = 1T$

$$\begin{aligned} V_C &= V_S \left(1 - e^{-\frac{t}{T}} \right) \\ &= V_S \left(1 - e^{-\frac{T}{T}} \right) \checkmark \\ &= V_S (1 - e^{-1}) \\ &= 12(1 - e^{-1}) \checkmark \\ &= 7.585 \text{ V} \checkmark \end{aligned}$$

(3)

OR

$$\begin{aligned} V_C @ t &= 1T \\ &= 63.2\% \text{ of } V_S \checkmark \\ &= \frac{63.2}{100} \times 12 \checkmark \\ &= 7.584 \text{ V} \checkmark \end{aligned}$$

$$V_R$$

$$V_R @ t = 1T$$

$$\begin{aligned} V_R &= E_M \left(e^{-\frac{1T}{T}} \right) \checkmark \\ &= E_M (e^{-1}) \\ &= 12(e^{-1}) \checkmark \\ &= 4.415 \text{ V} \checkmark \end{aligned}$$

(3)

OR

$$V_R @ t = 1T$$

$$\begin{aligned} &= V_T - V_C @ 1 \checkmark \\ &= 12 - 7.585 \checkmark \\ &= 4.415 \text{ V} \checkmark \end{aligned}$$

1.1.2 $V_C @ t = 5T$

$$V_C = V_S \left(1 - e^{\frac{-t}{T}}\right)$$

$$V_C = V_S \left(1 - e^{\frac{-5T}{T}}\right) \checkmark$$

$$V_C = V_S (1 - e^{-5})$$

$$= 12(1 - e^{-5}) \checkmark$$

$$= 11.919 V \checkmark$$

(3)

OR

$V_C @ t = 5T$

$$= 99.3\% \times V_T \checkmark$$

$$= \frac{99.3}{100} \times 12 \checkmark$$

$$= 11.916 V \checkmark$$

$V_R @ t = 5T$

$$V_R = E_M \left(e^{\frac{-t}{T}}\right)$$

$$= E_M \left(e^{\frac{-5T}{T}}\right) \checkmark$$

$$= E_M (e^{-5})$$

$$= 12(e^{-5}) \checkmark$$

$$= 0.081 V \checkmark$$

(3)

OR

$$V_R = E_M \left(e^{\frac{-t}{T}}\right)$$

$$V_R = (100\% - 99.3\%) \times V_T \checkmark$$

$$= 0.7\% \times V_T$$

$$= \frac{0.7}{100} \times 12 \checkmark$$

$$0.084 V \checkmark$$

- 1.2
- Natural Frequency
 - Resonant Frequency

(2)
[14]

QUESTION 2

2.1

$$V_D = V_S \left[\frac{R_1}{R_1 + R_2} - \frac{R_3}{R_3 + R_{TH}} \right] \checkmark$$

$$\frac{V_D}{V_S} = \frac{R_1}{R_1 + R_2} - \frac{R_3}{R_3 + R_{TH}} \checkmark$$

$$\frac{V_D}{V_S} + \frac{R_3}{R_3 + R_{TH}} = \frac{R_1}{R_1 + R_2} \checkmark$$

$$R_1 + R_2 = \left[\frac{R_1}{\frac{V_D}{V_S} + \frac{R_3}{R_3 + R_{TH}}} \right] \checkmark \checkmark$$

$$R_2 = \left[\frac{R_1}{\frac{V_D}{V_S} + \frac{R_3}{R_3 + R_{TH}}} \right] - R_1 \checkmark \checkmark$$

$$= \left[\frac{100}{\left(\frac{404 \times 10^{-3}}{5} + \frac{100}{100 + 138.5} \right)} \right] - 100 \checkmark \checkmark$$

$$= 100 \Omega \checkmark$$

(10)

- 2.2
- Passive transducers are dependent on an external source of power to produce an output.
 - Active transducers do not depend/require an external source of power to produce an output.

(2)
[12]

QUESTION 3

- 3.1 D
3.2 C
3.3 A
3.4 B
3.5 D
3.6 C
3.7 A
3.8 B
3.9 A

(9 × 1) [9]

QUESTION 4

- 4.1 4.1.1 Greater
 4.1.2 Higher
 4.1.3 Ultraviolet
 4.1.4 Smaller
(4 × 1) (4)
- 4.2 Step 1: Convert % efficiency to efficient per unit

 $0.588 \% \Rightarrow 0.588 \div 100 \checkmark$

 $= \frac{0.588}{100} = 0.00588 \text{ per unit}^2 \checkmark$ (2)
 Step 2:

 $\eta = 1.4 \times 10^{-9} \times E \times Z \checkmark$

 $\therefore Z = \frac{\eta}{E \times 1.4 \times 10^{-9}} \checkmark$

 $= \frac{0.00588}{100 \times 10^3 \times 1.4 \times 10^{-9}} \checkmark$

 $Z = 42 \checkmark$ (4)

 Name of target material = Molybdenum $\checkmark$ (1)
[11]

QUESTION 5

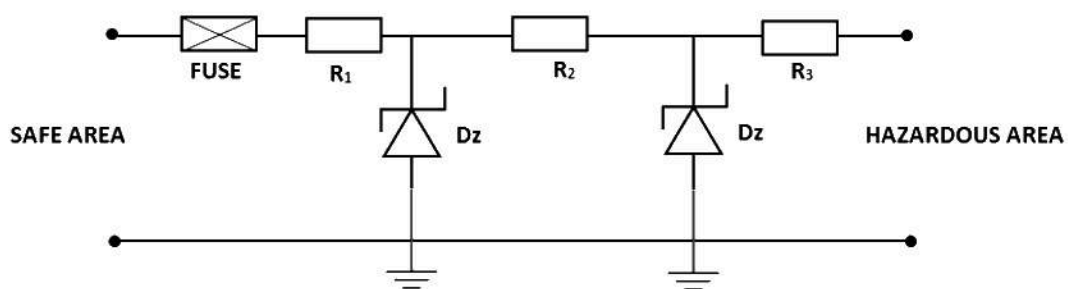
- 5.1 5.1.1 The items have failed the inspection, but they can be re-worked.
 5.1.2 The items have passed the inspection test and can now
 be packaged.
 5.1.3 The items have failed the inspection and cannot be worked on any
 further, they are now waste products.
(3 × 1) (3)
- 5.2 • Reference Oscillator
 • Search Oscillator/Detector Oscillator (2)
- 5.3 Initially the two oscillators are tuned to the same frequency. (2)
- 5.4 Zero Hz. (1)
- 5.5 The output signal frequency will be the difference between the values of the
 reference and detector oscillators. (2)
[10]

QUESTION 6

- | | | | | |
|-----|-------|------------------------------|---------|-----|
| 6.1 | 6.1.1 | Photoelectric safety devices | | |
| | 6.1.2 | Positive Protection | | |
| | 6.1.3 | Negative Protection | | |
| | 6.1.4 | Intrinsic Safe Equipment | | |
| | | | (4 × 1) | (4) |

- | | | | | |
|-----|-------|---|--|-----|
| 6.2 | 6.2.1 | C | | |
| | 6.2.2 | A | | |
| | 6.2.3 | B | | |
| | | | | (3) |

6.3



Mark Allocation

Allocate 1 full mark for each of the following: Dz, Safe Area, Hazardous Area, and any two correct half marks

(5)
[12]

QUESTION 7

- | | | | | |
|-----|-------|-------------|--|-----|
| 7.1 | 7.1.1 | Open Loop | | |
| | 7.1.2 | Not Present | | |
| | 7.1.3 | Unmonitored | | |
| | 7.1.4 | Input | | |
| | 7.1.5 | Output | | |
| | | | | (5) |

- | | | | | |
|-----|-------|-------------|---------|-----|
| 7.2 | 7.2.1 | Closed Loop | | |
| | 7.2.1 | Open Loop | | |
| | | | (2 × 1) | (2) |

- | | | | | |
|-----|-------|------------------------------|---------|-----|
| 7.3 | 7.3.1 | Computer-Aided Design | | |
| | 7.3.2 | Computer-Aided Manufacturing | | |
| | | | (2 × 1) | (2) |
| | | | | [9] |

QUESTION 8

RL circuit current during energizing cycle:

$$i = I_m \left(1 - e^{\frac{-t}{T}} \right) \checkmark$$

$$T = \frac{L}{R}$$

$$= \frac{0.5}{20} \checkmark$$

$$= 0.025 \text{ s} \checkmark$$

(3)

$$= 25 \text{ ms}$$

$$\therefore i = \text{LATCHING CURRENT}$$

$$\text{from } i = I_m \left(1 - e^{\frac{-t}{T}} \right)$$

$$4 \text{ mA} = i = \frac{V}{R} \left(1 - e^{\frac{-t}{T}} \right) \checkmark$$

$$4 \text{ mA} = \frac{100}{20} \left(1 - e^{\frac{-t}{25 \text{ ms}}} \right) \checkmark$$

$$4 \text{ mA} = 5 \left(1 - e^{\frac{-t}{25 \text{ ms}}} \right) \checkmark$$

$$\frac{4 \times 10^{-3}}{5} = \left(1 - e^{\frac{-t}{25 \text{ ms}}} \right) \checkmark$$

$$0.0008 = 1 - e^{\frac{-t}{0.025}} \checkmark$$

$$0.0008 - 1 = - e^{\frac{-t}{0.025}} \checkmark$$

$$-0.9992 = - e^{\frac{-t}{0.025}} \checkmark$$

$$0.9992 = e^{\frac{-t}{0.025}}$$

$$\ln 0.9992 = \ln e^{\frac{-t}{0.025}} \checkmark$$

$$-0.0008 = \frac{-t}{0.025} \checkmark$$

$$t = 0.0008 \times 0.025$$

$$t = 20 \mu\text{s} \checkmark$$

(10)

QUESTION 9

- 9.1 C
- 9.2 E
- 9.3 A
- 9.4 B
- 9.5 D

(5 × 2) [10]

TOTAL: 100