higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

22 November 2022

This marking guideline consists of 7 pages.

QUESTION 1

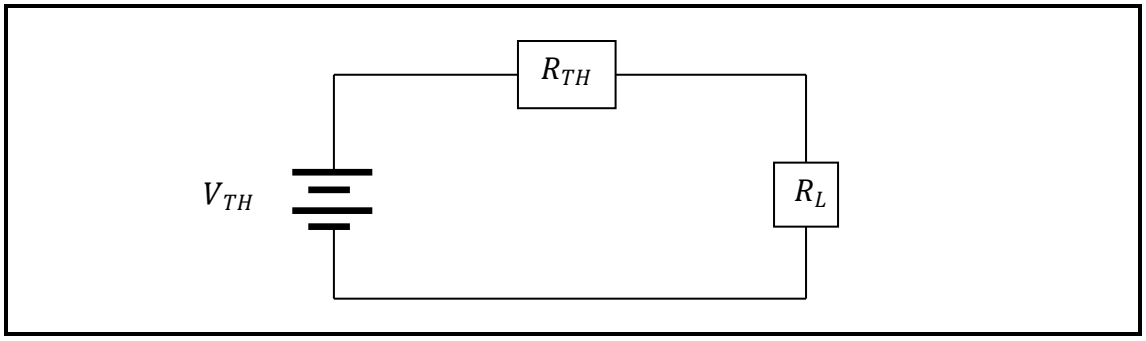
1.1

$$V_{AB} = \frac{R_2}{R_1+R_2} \times V_1 = \frac{1.1}{2+1.1} \times 6 = 2{,}129\ V\checkmark$$

$$V_{BA} = \frac{R_1}{R_1+R_2} \times V_2 = \frac{2}{2+1.1} \times 9 = 5{,}806\ V\checkmark$$

$$V_{TH} = V_{AB} + V_{BA} = 2{,}129 + 5{,}806 = 7{,}935\ V\ \checkmark\checkmark$$

$$R_{TH} = \frac{R_1 \times R_2}{R_1+R_2} = \frac{2 \times 1.1}{2+1.1} = 0{,}710\ \Omega\checkmark\checkmark$$



$$I_{R_L} = \frac{V_{TH}}{R_{TH}+R_L} = \frac{7{,}935}{0{,}71+16} = 0{,}475\ A\checkmark\checkmark$$

(8)

1.2

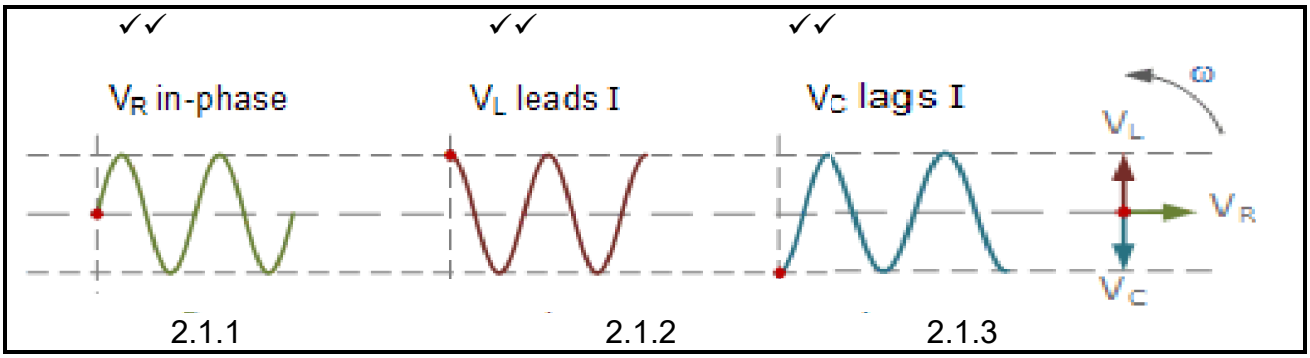
- Remove the load resistor and label terminals A and B where the load is removed.
- Calculate V_{TH} that appears across these terminals.
- Short-circuit all voltage sources and open-circuit all current sources.
- Calculate R_{TH} between both terminals A and B.
- Draw the Thevenin equivalent circuit with V_{TH} and R_{TH}.
- Insert the load resistor between terminals A and B.
- Calculate the required current/voltage.

(Any 2 × 1) (2)

[10]

QUESTION 2

2.1



(3 × 2) (6)

2.2
$$BW = f_H - f_L = \Delta f = \frac{f_r}{Q} = \frac{5 \times 10^6}{250} = 20\ kHz$$

$$f_L = f_r - \frac{\Delta f}{2} = 5 \times 10^6 - \frac{20 \times 10^3}{2} = 4{,}990\ MHz$$

$$f_H = f_r + \frac{\Delta f}{2} = 5 \times 10^6 + \frac{20 \times 10^3}{2} = 5{,}010\ MHz$$ (3)

2.3 2.3.1
$$Z_A = \frac{V_S}{I_A} = \frac{100\angle 0^0}{10\angle 0^0} = 10\angle 0^0$$

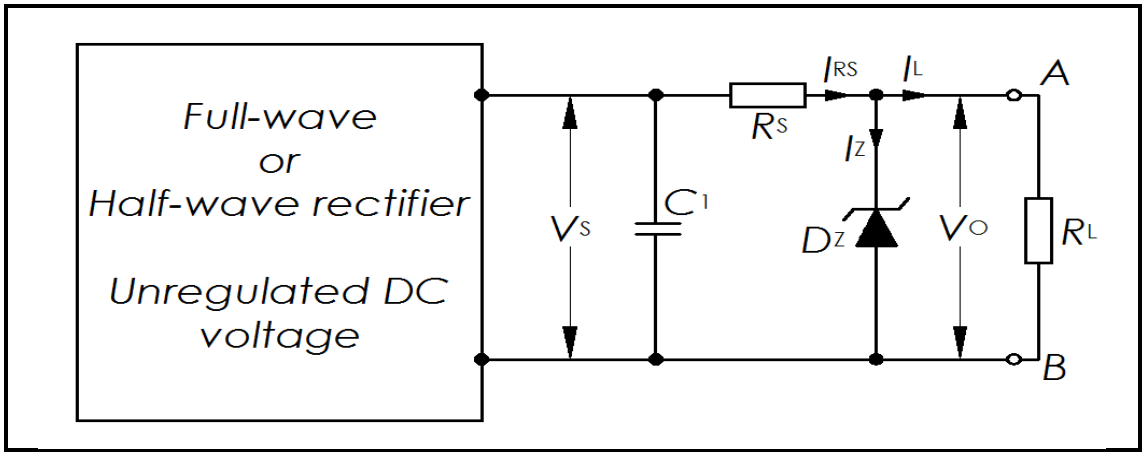
2.3.2
$$Z_B = \frac{V_S}{I_B} = \frac{100\angle 0^0}{13{,}426\angle -147{,}5^0} = 7{,}448\angle 147{,}5^0$$

2.3.3
$$Z_C = \frac{V_S}{I_C} = \frac{100\angle 0^0}{5{,}614\angle 63{,}3^0} = 17{,}813\angle -63{,}3^0$$

(3 × 2) (6)
[15]

QUESTION 3

3.1 3.1.1



(3)

3.1.2
- If the current through RL increases, the Zener current will fall with the corresponding amount.
- If the load current through RL decreases, the Zener current will increase with the corresponding amount. (2)

3.2 $$V = \frac{kT}{q}\ln\left(\frac{i}{I_s} + 1\right) = \frac{1{,}38 \times 10^{-23} \times (273 + 17)}{1{,}6 \times 10^{-19}}\ln\left(\frac{1{,}5 \times 10^{-3}}{12 \times 10^{-6}} + 1\right) = 0{,}121\ V$$ (3)

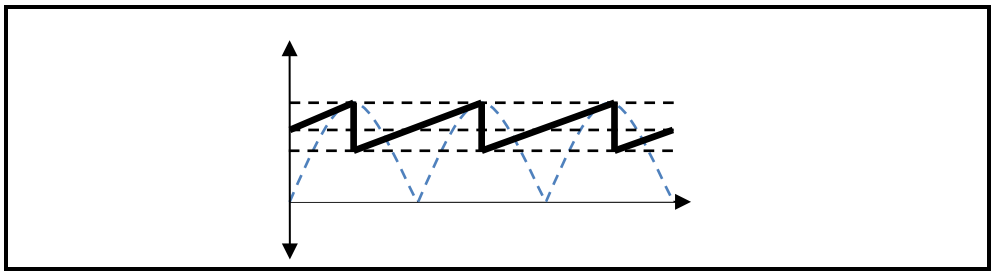
3.3
- Varactor diodes make less noise compared to other conventional diodes.
- They are available at low cost.
- The varactor diodes are small in size and therefore very lightweight.
- Varactor diodes are more reliable.
- Varactor diodes have no purpose when operated in forward bias.
- An increase in the reverse bias of varactor diodes causes an increase in the capacitance. (Any 2 × 1) (2)

[10]

QUESTION 4

4.1 4.1.1 Full (1)

4.1.2



(2)

4.1.3 $$V_{dc} = V_p - \frac{I_{dc}}{4fC} = 15 - \frac{10 \times 10^{-3}}{4 \times 50 \times 30 \times 10^{-6}} = 10\ V$$ (3)

4.1.4 $$V_{r(rms)} = \frac{I_{dc}}{4\sqrt{3}fC} = \frac{10 \times 10^{-3}}{4 \times \sqrt{3} \times 50 \times 10 \times 10^{-6}} = 2{,}887\ V$$ (3)

4.1.5 $$R_L = \frac{V_{dc}}{I_{dc}} = \frac{10}{10 \times 10^{-3}} = 1\ k\Omega$$ (2)

4.2
- Step-up transformer
- Autotransformer
- Step-down transformer
- Isolation transformer (Any 2 × 1) (2)

4.3 Is the process of converting an alternating voltage to a unidirectional voltage. (2)

[15]

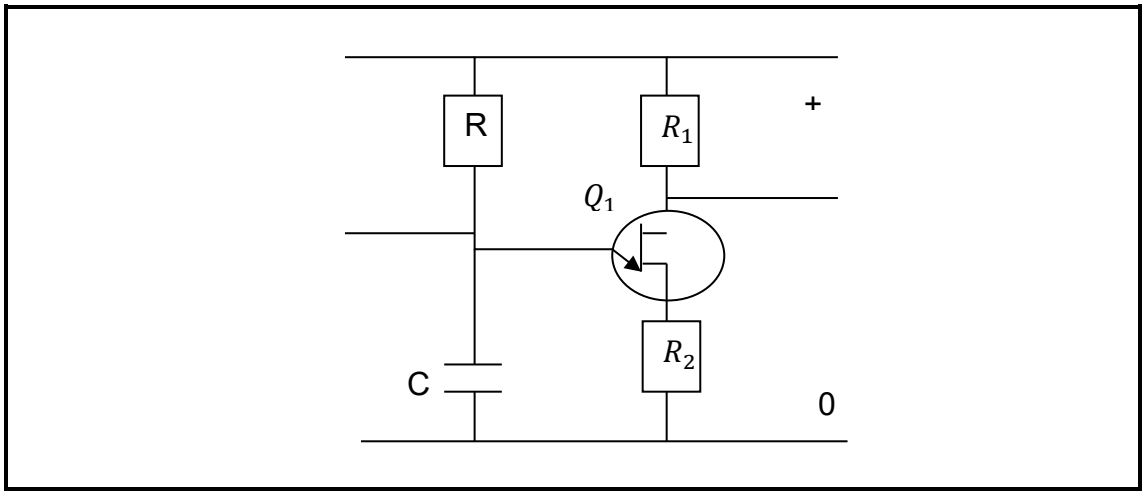
QUESTION 5

5.1 It is a semiconductor device consisting of two PN junctions. (1)

5.2 5.2.1 Static values are calculated when a transistor has no AC signal, i.e. the values are calculated at the Q-point in the steady-state.

5.2.2 Dynamic values are calculated when there is an AC input signal applied to the amplifier, i.e. the values are calculated as the parameters change for a corresponding changing AC input signal.
(2 × 2) (4)

5.3



(4)

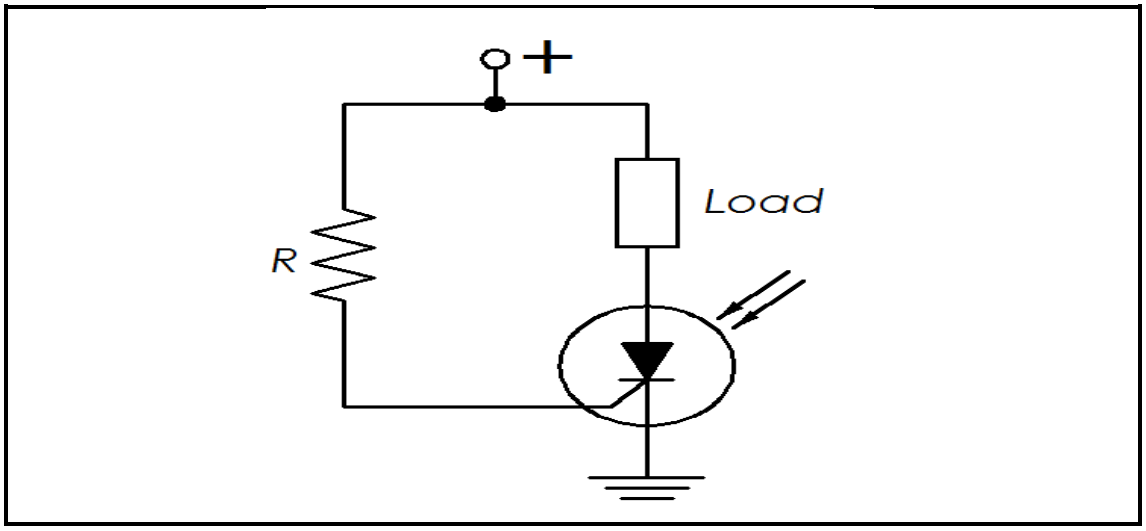
5.4 5.4.1 False
5.4.2 True
5.4.3 True
5.4.4 True
5.4.5 False
(5 × 1) (5)
[14]

QUESTION 6

6.1 F
6.2 A
6.3 E
6.4 B
6.5 C
(5 × 2) **[10]**

QUESTION 7

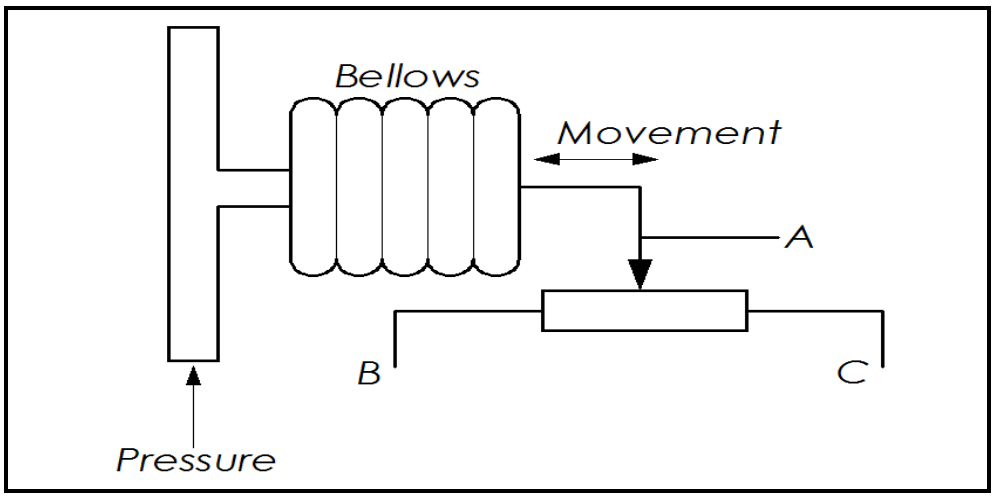
7.1



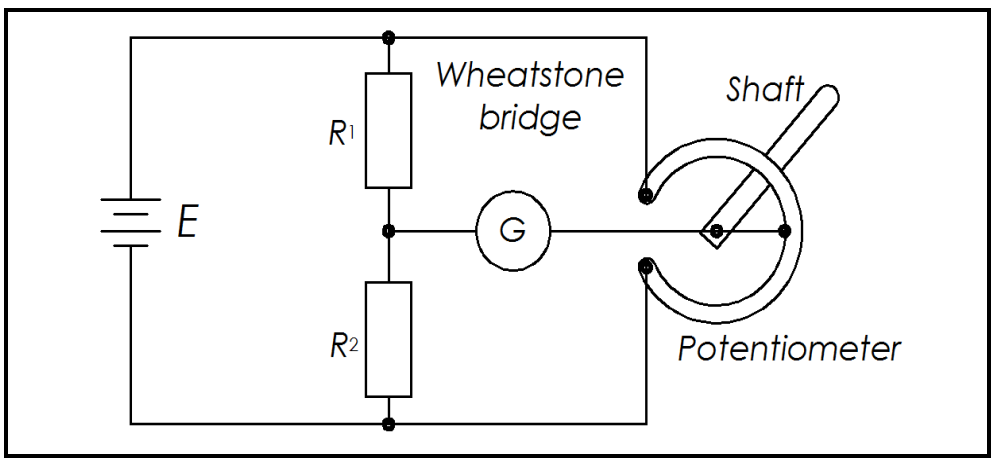
(3)

- When no light is present, the LASCR is off, no current flows through the load.
- When the light activates the LASCR, it turns on, allowing current to flow through load.
- The resistor is used to set the triggering level of the LASCR. (3)

7.2 7.2.1



7.2.2



(2 × 4) (8)

7.3
- Resistive
- Capacitive
- Inductive
- Photo-sensistive (Any 2 × 1) (2)

[16]

QUESTION 8

8.1 8.1.1 $V_{in} = no.\ of\ divs \times \frac{volts}{div} = 3 \times 4 = 12\ V$ (2)

8.1.2 $t = no.\ of\ divs \times \frac{time}{div} = 8 \times 2 \times 10^{-6} = 12\ \mu sec$

$f = \frac{1}{t} = \frac{1}{12 \times 10^{-6}} = 83{,}333\ kHz$ (4)

8.2
- Sine wave
- Square wave
- Triangular (sawtooth) wave (Any 2 × 1) (2)

8.3
- Gas focusing
- Electrostatic focusing
- Electromagnetic focusing (Any 2 × 1) (2)

[10]

TOTAL: 100