



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

26 November 2024

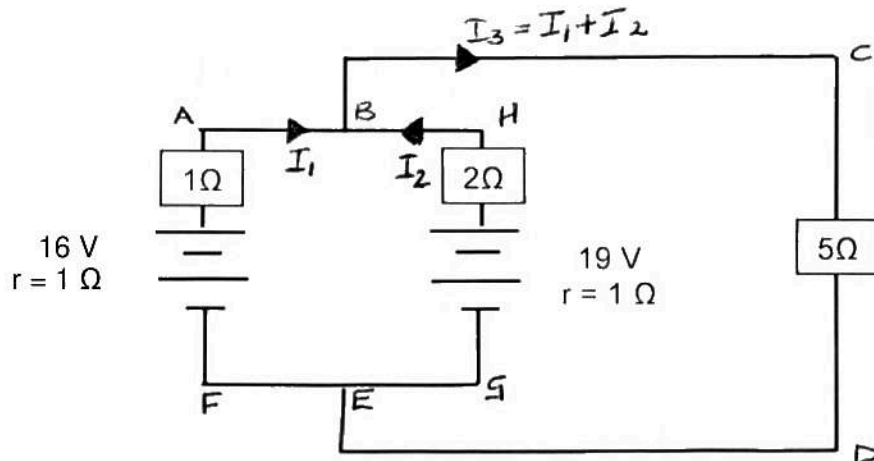
This marking guideline consists of 7 pages.

QUESTION 1

- 1.1
- Replace all voltage sources except one with a short circuit. If the voltage source has internal resistance, replace it with its internal resistance.
 - From the resulting series-parallel circuit combination, calculate the magnitude and direction of the current through appropriate resistors.
 - Repeat steps 1 and 2 for each active voltage source.
 - Algebraically add all the currents (or voltage drops) recorded in step 2 to determine the resultant current.

(4)

1.2



Loop ABCDEFA

$$16 = 2I_1 + 5(I_1 + I_2)$$

$$16 = 7I_1 + 5I_2 \quad \dots 1 \checkmark \checkmark$$

$$80 = 35I_1 + 25I_2 \quad \dots 1 \times 5 \checkmark$$

Loop HBCDEGH

$$19 = 3I_2 + 5(I_1 + I_2)$$

$$19 = 5I_1 + 8I_2 \quad \dots 2 \checkmark \checkmark$$

$$133 = 35I_1 + 56I_2 \quad \dots 2 \times 7 \checkmark$$

$$2 - 1$$

$$53 = 31I_2$$

$$I_2 = 1,71 A \checkmark$$

$$\text{If} \quad I_2 = 1,71 A$$

$$\therefore I_1 = 1,06 A \checkmark$$

$$V_{RL} = I_3 \times R_L = 2,77 \times 5 = 13,85 V \checkmark \checkmark$$

(10)

- 1.3 Any linear two-terminal network containing resistances and sources✓ can be replaced by a single source of EMF (V_{th})✓ in series with a single resistance (R_{th}).✓ (3)
- 1.4 The power transferred from a signal source into a load will be at a maximum when the load resistance is equal to the resistance of the source.✓✓✓ (3)
- [20]

QUESTION 2

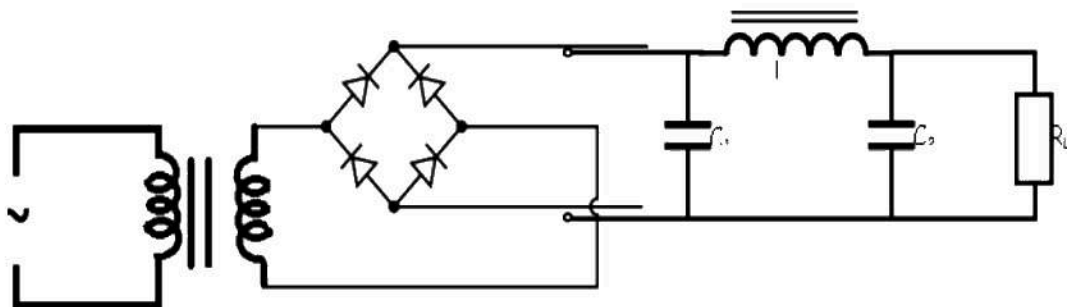
- 2.1
- When an AC current flows through a resistor, the current and voltage remains in phase.✓✓
 - When an AC current flows through an inductor, the current lags the voltage by an angle of 90° or the voltage leads the current by an angle of phase 90° .✓✓
 - When an AC current flows through a capacitor, the current leads the voltage by an angle of 90° or the voltage lags the current by an angle of phase 90° .✓✓
- (6)
- 2.2
- 2.2.1 $f_r = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{30 \times 10^{-3} \times 3 \times 10^{-6}}} \checkmark = 529 \text{ Hz} \checkmark$ (2)
- 2.2.2 $I = \frac{V}{R} = \frac{12}{48} \checkmark = 250 \text{ mA} \checkmark$ (2)
- 2.2.3 $V_R = IR = 48 \times 0.25 = 12 \text{ V} \checkmark$
 $X_L = 2\pi fL = 2\pi \times 529 \times 0.03 = 99,727 \Omega \checkmark \checkmark$
 $V_L = V_C = I \times X_L = 0.25 \times 99,727 = 24,932 \text{ V} \checkmark \checkmark$ (5)
- 2.2.4 $Q = \frac{X_L}{R} = \frac{99,727}{48} = 2,078 \checkmark \checkmark$ (2)
- 2.2.5 $BW = \Delta f = f_H - f_L = \frac{f_r}{Q} = \frac{529}{2,078} = 253,609 \text{ Hz} \checkmark$
 $f_L = f_r - \frac{\Delta f}{2} = 529 - \frac{253,609}{2} = 402,196 \text{ Hz} \checkmark$
 $f_H = f_r + \frac{\Delta f}{2} = 529 + \frac{253,609}{2} = 655,804 \text{ Hz} \checkmark$ (3)
- [20]

QUESTION 3

- 3.1 $v = \frac{kT}{q} \ln\left(\frac{i}{I_s} + 1\right) = \frac{1.38 \times 10^{-23} \times 300}{1.6 \times 10^{-19}} \ln\left(\frac{5 \times 10^{-3}}{25 \times 10^{-6}} + 1\right) = 0.137 V \checkmark \checkmark \checkmark \checkmark \checkmark$ (5)
- 3.2
- SCR conducts during one half cycle, while a TRIAC conducts during both cycles. (2)
 - SCR controls a small DC motor, while a TRIAC controls a small AC motor. (2)
- 3.3
- | | |
|-------|-------|
| 3.3.1 | False |
| 3.3.2 | True |
| 3.3.3 | True |
| 3.3.4 | False |
| 3.3.5 | True |
- (5 × 1) (5)
- 3.4
- The anode must be connected to the positive terminal.
 - The cathode must be connected to the negative terminal.
 - The gate must be exposed to light.
- (3)
[15]

QUESTION 4

- 4.1
- | | |
|-------|---|
| 4.1.1 | G |
| 4.1.2 | A |
| 4.1.3 | F |
| 4.1.4 | B |
| 4.1.5 | D |
- (5 × 1) (5)
- 4.2
- Centre tap
 - Bridge
- (2)
- 4.3 $V_{dc} = V_m - \frac{I_{dc}}{2fC} = 15 - \frac{110 \times 10^{-3}}{2 \times 50 \times 300 \times 10^{-6}} = 11.33 V \checkmark \checkmark \checkmark$ (3)
- 4.5



$\checkmark \checkmark \checkmark \checkmark \checkmark$ (5)
[15]

QUESTION 5

5.1 Gain is the ratio of the output signal to the input signal. (1)

5.2 5.2.1 $A_p = A_v \times A_i = 100 \times 10 = 1000 \checkmark \checkmark$ (2)

5.2.2 $A_v = 20 \log 100 = 40 \text{ dB}$
 $A_i = 20 \log 10 = 20 \text{ dB}$
 $A_p = 10 \log 1000 = 30 \text{ dB}$ (3)

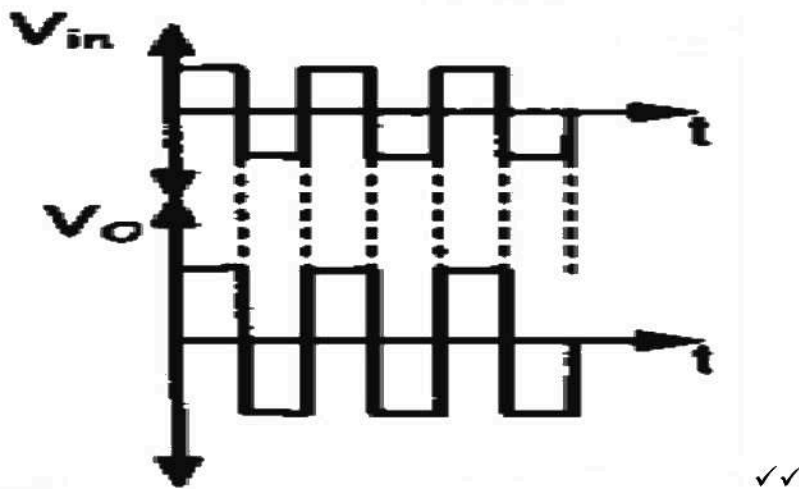
5.3 5.3.1 The complementary-symmetry push-pull Class AB $\checkmark \checkmark$ (2)

5.3.2

- During the positive half-cycle, Q_1 is cut off and Q_2 conducts.
- During the negative half, Q_2 is cut off and Q_1 conducts.
- The resulting waveform across R_L is an amplified version of the input signal.

(3)

5.4 $V_{out} = \left(\left(1 + \frac{R_f}{R_{in}} \right) \cdot V_{in} \right) = \left(1 + \frac{12\,000}{1200} \right) \cdot 1 = 11 \text{ V} \checkmark \checkmark$

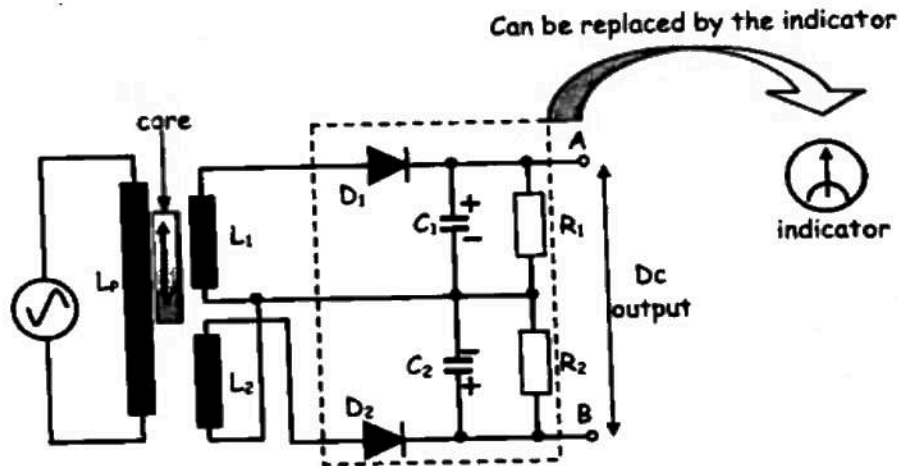


(4)
[15]

QUESTION 6

6.1 The strain gauge is a resistive transducer which converts the mechanical displacement (elongation and compression) into a resistance change.✓✓ (2)

6.2



✓✓✓✓✓

(5)

- 6.3
- Servo-motors
 - Recorders
 - Indicators
 - Controllers

(Any 3 × 1)

(3)

6.4 Liquid crystal display is a flat screen that uses liquid crystals and polarisers to control light for the display.✓✓

OR

Liquid crystal display is a display that manipulates a liquid crystal layer's optical properties by varying its electric voltage.

OR

Liquid crystal display is a device that uses properties of liquid crystals controlled by an electrical field for visual display.

OR

Liquid crystal display is a low powered, flat-panel digital display that uses liquid crystal molecules and that changes its optical properties in the presence of an applied electric field.

(Any 1 × 2)

(2)

- 6.3
- TV sets
 - Computer monitors
 - Air crafts cockpit displays
 - Instrument panels
 - Indoor and outdoor signs
 - Small screens in projectors, digital cameras, watches, calculators and smartphones
- (Any 3 × 1) (3)
[15]
- TOTAL: 100**