higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

26 November 2024

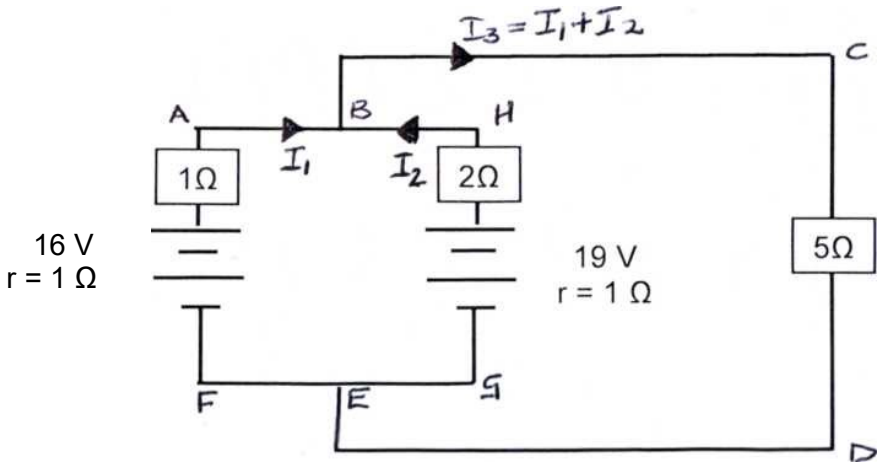
This marking guideline consists of 7 pages.

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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

$\mathbf{16 = 2I_1 + 5(I_1 + I_2)}$

$\mathbf{16 = 7I_1 + 5I_2}$ ...1✓✓

$\mathbf{80 = 35I_1 + 25I_2}$ ...1 × 5 ✓

Loop HBCDEGH

$\mathbf{19 = 3I_2 + 5(I_1 + I_2)}$

$\mathbf{19 = 5I_1 + 8I_2}$ ...2✓✓

$\mathbf{133 = 35I_1 + 56I_2}$ ...2 × 7 ✓

2 – 1

$\mathbf{53 = 31I_2}$

$\mathbf{I_2 = 1,71\ A}$✓

If $\mathbf{I_2 = 1,71\ A}$

$\mathbf{\therefore I_1 = 1,06\ A}$ ✓

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

(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 an 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 $f_r = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{30\times10^{-3}\times3\times10^{-6}}}$✓ $= 529\ Hz$✓ (2)

2.2.2 $I = \frac{V}{R} = \frac{12}{48}$✓ $= 250\ mA$✓ (2)

2.2.3 $V_R = IR = 48 \times 0.25 = 12V$✓

$X_L = 2\pi fL = 2\pi \times 529 \times 0.03 = 99,727\Omega$✓✓

$V_L = V_C = I \times X_L = 0.25 \times 99,727 = 24,932\ V$✓✓ (5)

2.2.4 $Q = \frac{X_L}{R} = \frac{99,727}{48} = 2,078$✓✓ (2)

2.2.5 $BW = \Delta f = f_H - f_L = \frac{f_r}{Q} = \frac{529}{2,078} = 253,609\ H_Z$✓

$f_L = f_r - \frac{\Delta f}{2} = 529 - \frac{253,609}{2} = 402,196\ H_Z$✓

$f_H = f_r + \frac{\Delta f}{2} = 529 + \frac{253,609}{2} = 655,804\ H_Z$✓ (3)
[20]

QUESTION 3

3.1 $v = \frac{kT}{q}\ln(\frac{i}{I_S}+1) = \frac{1.38\times10^{-23}\times300}{1{,}6\times10^{-19}}\ln(\frac{5\times10^{-3}}{25\times10^{-6}}+1) = 0.137\ V$✓✓✓✓✓ (5)

3.2
- SCR conducts during one half cycle, while a TRIAC conducts during both cycles.
- 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

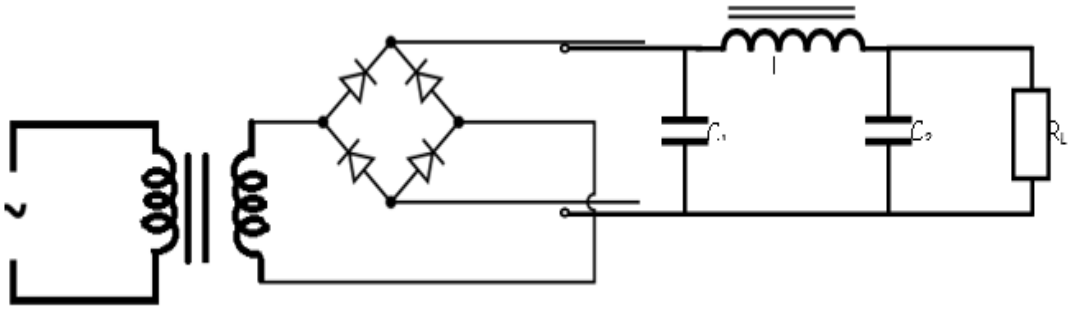
4.1
4.1.1 G
4.1.2 A
4.1.3 F
4.1.4 B
4.1.5 D

(5 × 1) (5)

4.2
- Centre tap
- Bridge (2)

4.3 $V_{dc} = V_m - \frac{I_{dc}}{2fC} = 15 - \frac{110\times10^{-3}}{2\times50\times300\times10^{-6}} = 11.33V$✓✓✓ (3)

4.5



✓✓✓✓✓ (5)

[15]

QUESTION 5

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

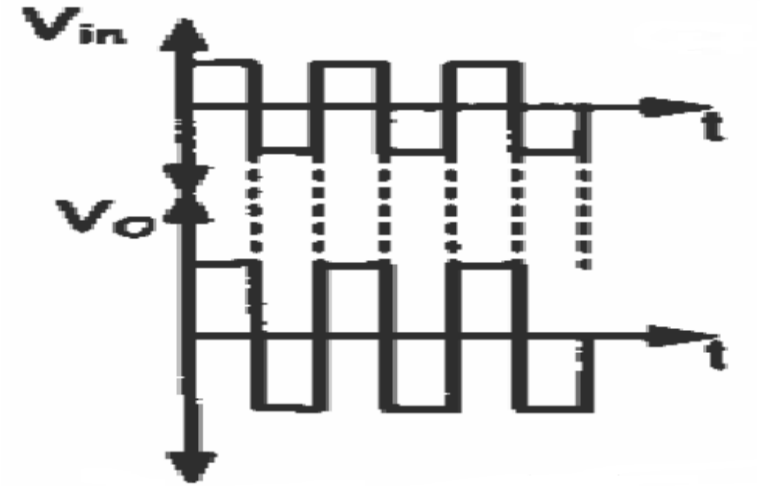
5.2 5.2.1 $\boldsymbol{A_P = A_V \times A_i = 100 \times 10 = 1000}$✓✓ (2)

5.2.2 $A_V = 20\log 100 = 40\ dB$
$A_i = 20\log 10 = 20\ dB$
$A_p = 10\log 1000 = 30\ dB$ (3)

5.3 5.3.1 The complementary-symmetry push-pull Class AB✓✓ (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 $\boldsymbol{V_{out} = \left(\left(1 + \frac{R_f}{R_{in}}\right).V_{in}\right) = \left(1 + \frac{12\,000}{1200}\right).1 = 11\ V}$✓✓

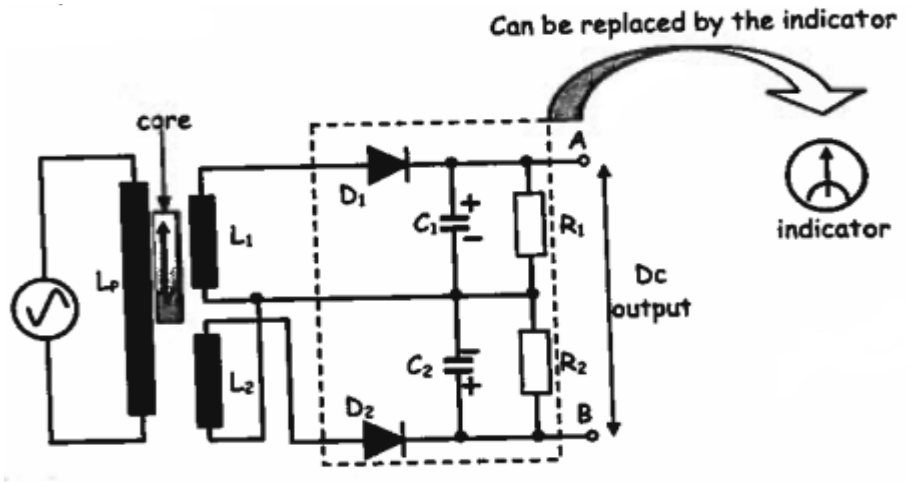


✓✓ (4)
[15]

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

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