higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

7 April 2020

This marking guideline consists of 7 pages.

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QUESTION 1

1.1 1.1.1 In any linear multiple-source network, the resultant current in any branch is the algebraic sum of the current that would be produced by each source acting separately.

1.1.2 Any network can be viewed as a two-terminal network and can be replaced by a single source of EMF (V_{th}) in series with a single resistance (R_{th}).

(2 × 2) (4)

1.2 Consider loop ABCA

$0 = 10I_1 + 5I_2 – 5I_3 – 20I_2$

$0 = 15I_1 – 20I_2 – 5I_3$ ----------(1)✓✓ (2)

Consider loop BDCB

$0 = 30I_3 – 15[(I_1 – I_3) + I_2] – (I_1 – I_3)$

$0 = 30I_3 – 15I_1 + 15I_3 – 15I_2 – 5I_1 + 5I_3$

$0 = 20I_1 + 15I_2 – 50I_3$ ----------(2)✓✓ (2)

Consider loop ABDA

$5 = 10I_1 + 30I_3$

$10I_1 = 5 – 30I_3$

$I_1 = 0,5 – 3I_3$ ----------(3)✓ (1)

(1) × 15: $0 = 225I_1 – 300I_2 – 75I_3$----------(4)✓ (1)

(2) × 20: $0 = 400I_1 + 300I_2 – 1000I_3$----------(5)✓ (1)

(4) + (5): $0 = 625I_1 – 1075I_3$----------(6) (1)

Subst. I_1 in (6): $0 = 625(0,5 – 3I_3)$

$I_3 = 0,106$ A✓ (1)

$I_1 = 0,5 – 3(0,106)$

$I_1 = 0,182$ A✓

$I_4 = I_1 – I_3$

$= 0,182 – 0,106$

$= 0,076$ A✓ (1)

[14]

QUESTION 2

2.1 $X_L = 2\pi fL$
$= 2 \times \pi \times 50 \times 0,2$
$= 62,84\ \Omega$✓ (1)

$$Xc = \frac{1}{2\pi fC} = \frac{1}{2 \times \pi \times 50 \times 100 \times 10^{-6}}$$

$= 31,827\ \Omega$✓ (1)

2.2 2.2.1 $Z = R + j(X_L - X_C)$
$= 20 + j(62,84 - 31,827)$
$= 36,903 \angle 57,2^\circ\ \Omega$✓✓ (2)

2.2.2 $I_T = \frac{V_T}{Z_T}$

$= \frac{220\ \angle 0^\circ}{36,903\ \angle 57,2^\circ}$

$= 5,962 \angle -57,2^\circ\ A$✓✓ (2)

2.2.3 $V_L = I_T \times X_L$
$= 5,962 \angle -57,2^0 \times 62,84 \angle 90^\circ$
$= 374,652 \angle 32,8^0\ V$✓✓ (2)

2.2.4 $V_C = I_T \times X_C$
$= 5,962 \angle -57,2^0 \times 31,827 \angle -90^\circ$
$= 189,753 \angle -147,2^\circ\ V$✓✓ (2)
[10]

QUESTION 3

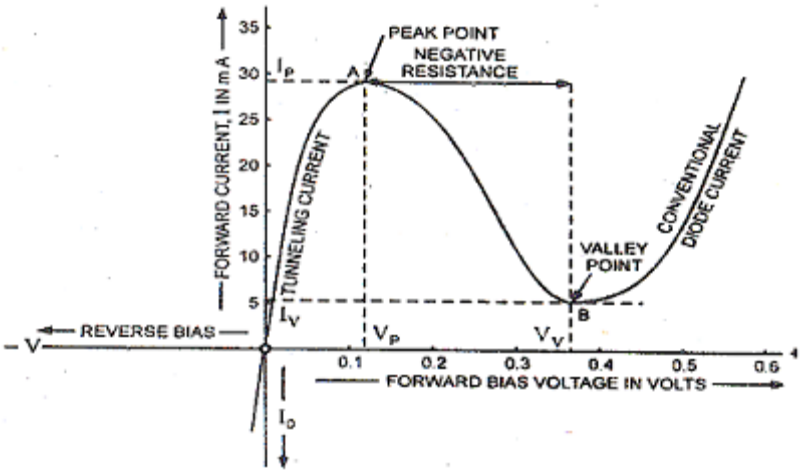
3.1 3.1.1 Process of generating free electrons

3.1.2 Process of generating holes

3.1.3 Movement of electrons crossing the junction

(3 × 2) (6)

3.2



(6)
[12]

QUESTION 4

4.1 4.1.1 The ratio of the number of turns in the primary to the number in the secondary is the turns ratio of the transformer

4.1.2 Process of converting an alternating voltage to a unidirectional voltage

4.1.3 The peak voltage appearing across a diode during the reverse condition period

4.1.4 A measure of the smoothness of the DC output of a rectifier

(4 × 2) (8)

4.2 $V_m = \sqrt{2} \times 240/2$
$= 169,706$ V✓

$V_{dc} = 0,637\ V_m$
$= 0,637 \times 169,706$
$= 108,102$ V✓

$PIV = 2\ V_m$
$= 2 \times 169,706$
$= 339,412$✓✓

(4)
[12]

QUESTION 5

5.1 It shows the fixed value of the voltage collector (V_{CE}). The base current increases as the base-emitter voltage (V_{BE}) increases. Increase in V_{CE} will result in an increase in V_{BE} to establish the same current. (4)

5.2 5.2.1

$I_{out} = \sqrt{(P_{out}/Z_{out})}$
$= \sqrt{(200/80)}$
$= 1,581$✓
$V_{out} = I_{out} \times Z_{out}$
$= 1,581 \times 80$
$= 126,491$ V✓
$A_V = 20\log 126,491/30$
$= 12,499$ dB✓ (3)

5.2.2

$I_{in} = P_{in}/V_{in}$
$= 15/30$
$= 0,5$ A✓

$A_i = 20\log(1,581/0,5)$
$= 10$ dB✓✓ (3)

5.3 The signal feedback is in antiphase (180° out of phase) with the input signal. (2)
[12]

QUESTION 6

6.1 $V_o = ((R_1 + R_f)/R_1)\ V_{in}$
$= ((25 + 30)/25) \times 5$
$= 11$ V✓
$A_v = V_o/V_{in}$
$= 11/5$
$= 2,2$✓✓ (3)

6.2 $V_o = R_f\ (V_1/R_1 + V_2/R_2 + V_3/R_3)$
$= 22 \times 10^3(5,5/10 \times 10^3 + 2,5/12 \times 10^3 + 1/17,5 \times 10^3)$✓✓
$= -17,94$ V✓✓ (4)

6.3 V_{in} = Rate of change × C × R_{in}✓
$= 0,9 \times 100 \times 10^{-6} \times 25 \times 10^3$✓
$= 2,25$ V✓ (3)
[10]

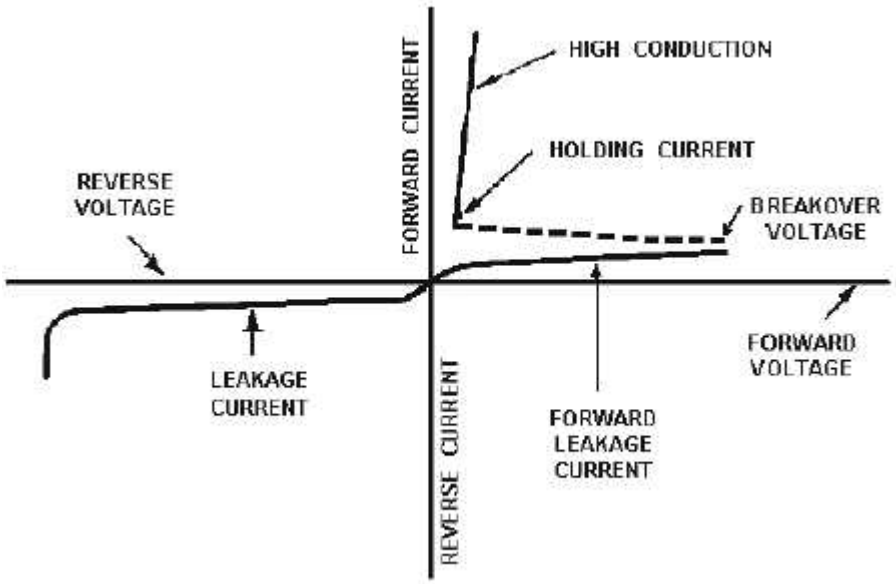
QUESTION 7

7.1 7.1.1 When a negative potential is applied to the anode with respect to the cathode, PN is reverse-biased and as a result, there is no current flowing through the thyristor.

7.1.2 When a positive potential is applied to the anode with respect to the cathode and no gate signal is applied, PN is biased.

(2 × 2) (4)

7.2



(5)

7.3 It compares the output with the reference input. (1)

[10]

QUESTION 8

8.1
- R_1 and R_3 are the ratio arms equal to each other.
- R_2 is the rheostat arm and has a value equal to the strain gauge resistance.
- When the gauge is unstrained, the bridge is balanced and the voltmeter shows a zero value.
- As there is a change in resistance in the strain gauge, the bridge gets unbalanced and produces an indication on the voltmeter.
- The output voltage from the bridge can be amplified further by a differential amplifier. (5)

8.2 8.2.1 The bridge will be out of balance due to change in length and in the area and resistance.

8.2.2 The bridge will be balanced and output in the galvanometer will be zero.

(2 × 1) (2)

8.3 When an incident light falls on the device, its resistance decreases causing a current to flow. (2)
[9]

QUESTION 9

9.1
- Electrostatic deflection
- Electromagnetic deflection (2)

9.2 9.2.1 It gets a sample of the input waveform and produces a synchronising pulse at some selected point on the input waveform and applies it to the time-base generator.

9.2.2 It delays the arrival of the input waveform at the vertical deflection plates until the trigger and time-base circuits have had a chance to start the sweep of the beam.

(2 × 2) (4)

9.3 9.3.1 $V_p = 2,7 \times 0,4$
$= 1,08$ V
$V_{p-p} = 2 \times 1,08$
$= 2,16$ V✓✓ (2)

9.3.2 $5 \times 2 \times 10^{-6}$
10 µsec✓

$F = 1/10 \times 10^{-6}$
$= 100$ kHz✓✓ (3)
[11]

TOTAL: 100

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