higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

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This marking guideline consists of 6 pages.

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QUESTION 1

1.1 Consider first loop:

$V_1 = R_{3\Omega} I_1 + R_{10\Omega}(I_1 + I_2)$
$32 = 3I_1 + 10(I_1 + I_2)$
$32 = 3I_1 + 10I_1 + 10I_2$
$32 = 13I_1 + 10I_2$
$13I_1 = 32 – 10I_2$
$I_1 = 2,462 – 0,769I_2$……1

Consider second loop:

$V_2 = R_{5\Omega}I_2 + R_{10\Omega}(I_1 + I_2)$
$15 = 5I_2 + 10I_1 + 10I_2$
$15 = 15I_2 + 10I_1$…….2

Substitute equ 1 in equ 2:

$15 = 15I_2 + 10(2,462 – 0,769I_2)$
$15 = 15I_2 + 24,62 – 7,69I_2$
$-9,62 = 7,31I_2$
$I_2 = 1,316$ A (opposite direction)

$I_1 = 2,462 – 0,769(1,316)$
$= 1,45$ A (7)

1.2 $V_{AB} = 3/(3 + 5) \times 12$
$= 4,5$ V

$V_{BA} = 5/(5 + 3) \times 32$
$= 20$ V

$V_{TH} = 20 – 4,5$
$= 15,5$ V

$R_{TH} = (3 \times 5)/(3 + 5)$
$= 1,875\ \Omega$

$P_L = (15,5/(1,875+1,875))^2 \times 1,875$
$= 32,033$ (5)
[12]

QUESTION 2

2.1 $-BW = \Delta F = 1\,500 \times 10^3/250$
$= 6$ kHz

$F_L = F_r - \Delta F/2$
$= 1\,500 \times 10^3 - 6 \times 10^3/2$
$= 1\,497$ kHz (3)

2.2 $X_{L1} = 2 \times \pi \times 50 \times 105 \times 10^{-3}$
$= 32{,}987\ \Omega$

$X_{L2} = 2 \times \pi \times 50 \times 45 \times 10^{-3}$
$= 14{,}137\ \Omega$

$X_{c2} = 1/(2 \times \pi \times 50 \times 78 \times 10^{-6})$
$= 40{,}809\ \Omega$

$Z_1 = 120 - j7{,}822$
$= 120{,}255 \angle -3{,}729\ \Omega$

$Z_2 = 80 + j14{,}137$
$= 81{,}24 \angle 10{,}021\ \Omega$

$Z_T = (120{,}255 \angle -3{,}729 \times 81{,}24 \angle 10{,}021)/(120\text{-}j7{,}822 + 80 + j14{,}137)$
$= 9\,769{,}516 \angle 6{,}292/201{,}202 \angle 6{,}266$
$= 48{,}555 \angle 0{,}026\ \Omega$

$I_T = V_T/Z_T$
$= 220 \angle 0/48{,}555 \angle 0{,}026$
$= 4{,}531 \angle -0{,}026$A (8)
[11]

QUESTION 3

3.1 3.1.1 A major means of conduction and therefore described as majority charge carriers

3.1.2 Generated by thermal or other means and also act as charge carriers; also known as minority charge carriers

(2 × 2) (4)

3.2 $R = KT/qi$
$T = Rqi/K$
$= (5{,}213 \times 1{,}6 \times 10^{-19} \times 5 \times 10^{-3})/1{,}38 \times 10^{-23}$
$= 302{,}203$
Temperature = 29 °C (5)

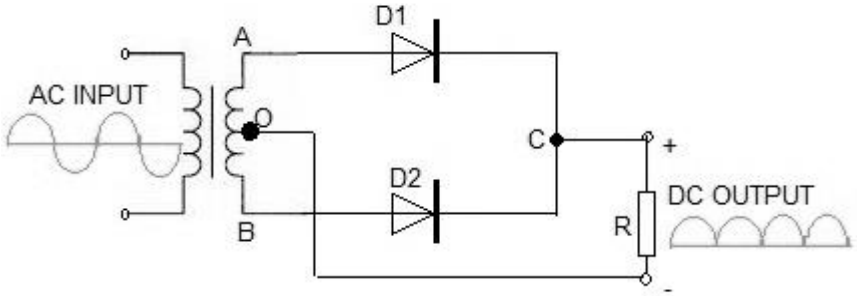
3.3
- Vericap diode
- Variable capacitor
- Tuning diode (Any 1 × 1) (1)

3.4 An increase in terminal voltage results in a reduction in diode current. (2)
[12]

QUESTION 4

4.1 The process of converting an alternating voltage to a unidirectional voltage (2)

4.2



Full Wave rectifier (Centre tap) (5)

4.3 $X_c = 1/(2 \times \pi \times 50 \times 150 \times 10^{-9})$
$= 21\ 220{,}659\ \Omega$

$V_{r(rms)} = X_C/\sqrt{(R^2 + X_C^2)} \times V_{r(rms)}$
$= 21\ 220{,}659/\sqrt{(1\ 200^2 + 21\ 220{,}659^2)} \times 4$
$= 3{,}994\ V$

$R = V_{r(rms)}/V_{dc}$
$= 3{,}994/30$
$= 0{,}133$ (4)
[11]

QUESTION 5

5.1 When both base-emitter and base-collector junctions are reverse biased (2)

5.2
- For class A: The bias point is so selected that there is current flow during the whole of the input signal i.e. in the middle.
- For class B: The bias point is at the cut-off region. (4)

5.3 5.3.1 When part of the feedback signal is connected in series with the input signal

5.3.2 When the input and output signals are converted to currents, added and reconverted to a voltage and applied to the amplifier
(2 × 2) (4)

5.4 It can be chosen anywhere on the load line but usually selected near the middle of the load line approximately ½ V_{cc}. (2)
[12]

QUESTION 6

6.1 $A_v = R_f/R_f$
$= 6 \times 10^3/3 \times 10^3$
$= 2$ A

$V_{in} = V_o/A_v$
$= 7,3/2$
$= 3,65$ V (4)

6.2 $V_o = -R_f(V_1/R_1 + V_2/R_2 + V_3/R_3)$
$-3,13 = 15 \times 10^3(8,35/2 + V_2/7 + 9,25/6)$
$-208 \times 10^{-6} = 5,717 + V_2/7$
$1 = -27\,483,974 – 686,813\ V_2$
$V_2 = -40,015$ V (5)

6.3 Comparator (1)
[10]

QUESTION 7

7.1 7.1.1 A group of semiconductor devices which have a rapid switch-on characteristic

7.1.2 Minimum value of the current needed to keep an SCR on
(2 × 2) (4)

7.2
- Generates transients
- Noisy
- Requires large heat sinks to control large powers
- Needs special smoothing circuits
- Needs special circuits for switching off under DC conditions (4)

7.3 By incident light falling upon the gate region which is normally supplied by the gate circuit (3)
[11]

QUESTION 8

8.1
- Physical quantity to be measured
- Accuracy
- Most suitable converting principle
- Environment in which the transducer will be used
- Type of supply available (Any 2 × 1) (2)

8.2 8.2.1 The bridge will be balanced and the output in the galvanometer will be zero. (2)

8.2.2 The bridge will be out of balance due to the change in length and thus in the area and resistance. (4)

8.3 Rotation of the shaft is imparted to the magnetic field of the armature. The magnetic coupling is increased and as it moves away from the armature. The magnetic field resumes its original strength. (3)
[11]

QUESTION 9

9.1
- Accelerates the electron beam
- Turns diverging electrons into a converging beam of electrons (2)

9.2 9.2.1 Produces a triangular waveform from the square-wave signal

9.2.2 Shaping circuit produces a sinusoidal type waveform from the triangular waveform
(2 × 2) (4)

9.3 9.3.1 Sine wave (1)
9.3.2 Square wave pulse (1)
9.3.3 Rectangular wave (2)
[10]

TOTAL: 100

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