MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

14 NOVEMBER 2012

This marking guideline consists of 8 pages.
QUESTION 1

Short circuit \( V_1 \)

\[
R_{p1A} = \frac{8 \times 15}{8 + 15} = 5,217 \, \Omega
\]

\[
R_{S1A} = 5,217 + 10 = 15,217 \, \Omega
\]

\[
R_{p2A} = \frac{15,217 \times 9}{15,217 + 9} = 5,655 \, \Omega
\]

\[
R_{TA} = 5,655 + 5 = 10,655 \, \Omega
\]

\[
V_2 = \frac{12}{R_{TA}} = \frac{12}{10,655} = 1,126 \, A
\]

\[
I_{TA} = \frac{R_{S1A}}{R_{S1A} + 9}
\]

\[
= \frac{15,217}{15,217 + 9} \times 1,126
\]

\[
= 0,708 \, A
\]

Short circuit \( V_2 \)

\[
R_{p1B} = \frac{5 \times 9}{5 + 9} = 3,214 \, \Omega
\]

\[
R_{S1B} = 3,214 + 10 = 13,214 \, \Omega
\]

\[
R_{p2B} = \frac{13,214 \times 15}{13,214 + 15} = 7,025 \, \Omega
\]

\[
R_{TB} = 7,025 + 8 = 15,025 \, \Omega
\]

\[
V_1 = \frac{10}{R_{TB}} = \frac{10}{15,025} = 0,666 \, A
\]

\[
I_{TB} = \frac{15}{15 + R_{S1B}}
\]

\[
= \frac{15}{15 + 13,214} \times 0,666
\]

\[
= 0,354 \, A
\]

\[
I_{S1B} = \frac{5}{5 + 9} \times 0,354
\]

\[
= 0,126 \, A
\]

\[
l_{S2} = I_{S1A} + I_{S1B}
\]

\[
= 0,708 + 0,126
\]

\[
= 0,834 \, A
\]
QUESTION 2

2.1 \( X_L = 2\pi fL \)
\[
= 2 \times 3,142 \times 50 \times 0.15
\]
\( = 47,13 \, \Omega \)
\[ X_C = \frac{1}{2\pi fC} \]
\[
= \frac{1}{2 \times 3,142 \times 50 \times 200 \times 10^{-6}}
\]
\( = 15,913 \, \Omega \)

\( Z_T = R + j(X_L - X_C) \)
\[
= 12 + j(47,13 - 15,913)
\]
\( = 12 + j31,217 \)
\( = 33,444 \angle 69^0 \) \hspace{1cm} (2)

2.2 \( V_T = \frac{200 \angle 0^0}{Z_T} \)
\[
= \frac{200 \angle 0^0}{33,444 \angle 69^0}
\]
\( = 5.98 \angle -69^0 \) \hspace{1cm} (2)

2.3 \( V_L = I_T \times X_L \)
\[
= 5.98 \angle -69^0 \times 47,13 \angle 90^0
\]
\( = 281,737 \angle 21^0 \, V \) \hspace{1cm} (2)

\( V_C = I_T \times X_C \)
\[
= 5.98 \angle -69^0 \times 15,913 \angle -90^0
\]
\( = 95,16 \angle -159 \, V \) \hspace{1cm} (2)

[10]
QUESTION 3

3.1 3.1.1

3.1.2

3.1.3

3.1.4

3.2 RC π-filter or LC π-filter

3.3
- In the bridge circuit there are always two diodes conducting at the same times, resulting in a forward voltage drop of double that of the centre-tap circuit.
- In the bridge circuit the PIV across a reverse-biased diode is equal to the maximum voltage whereas the PIV for the centre-tap circuit diodes is twice the maximum voltage.
- The bridge circuit makes use of four diodes and the centre-tap circuit make use of two diodes.
- The bridge circuit performs a full-wave function without the use of a centre-tap transformer.
- The bridge can also be directly supplied from the ac source without the use of a transformer.

3.4

\[ i = I_s \left( e^{\frac{qV}{KT}} - 1 \right) \]

\[ v = \frac{KT}{q} \ln \left( \frac{i}{I_s} + 1 \right) \]

\[ = \frac{1.38 \times 10^{-23} \times 298}{1.6 \times 10^{-19}} \ln \left( \frac{5 \times 10^{-3}}{15 \times 10^{-5}} + 1 \right) \]

\[ = 0.151V \]
QUESTION 4

4.1  4.1.1  \[ \Delta V_{be} = 2 \]

\[ \frac{h_{ib}}{\Delta I_e} = \frac{1}{2 \times 10^6} = 1 \text{ M}\Omega \]

\[ \Delta V_{bc} = 6 \]

4.1.2  \[ \frac{1}{h_{ob}} = \frac{1}{\Delta I_c} = \frac{1}{4 \times 10^{-3}} = 1,5 \text{ k}\Omega \]

\[ \Delta V_{be} = 2 \]

4.1.3  \[ h_{rb} = \frac{\Delta V_{bc}}{\Delta I_c} = \frac{6}{4 \times 10^{-3}} = 0,333 \]

4.1.4  \[ h_{fb} = \frac{\Delta I_e}{\Delta I_c} = \frac{2 \times 10^{-6}}{4 \times 10^{-3}} = 2000 \]

4.2  • Relatively unaffected by radiation
  • No offset voltage when used as a switch
  • Very high input resistance
  • Considerable thermal stability
  • Less noisy than bipolar transistors
  • High packing density

(Any FIVE) (5)

4.3  Cross-over distortion occurs during the period when one transistor begins to switch off and the other one starts to switch on. (2) [15]

QUESTION 5

5.1  5.1.1

\[ \begin{array}{c}
R \\
\downarrow
\\
I
\\
\uparrow \\
C \\
\downarrow
\end{array} \]

\[ V_m \]

\[ V_o \]

5.1.2

\[ \begin{array}{c}
V_m \\
\downarrow
\\
+ \\
\uparrow \\
- \\
R_l \quad \quad R_f \\
\downarrow
\end{array} \]

\[ V_o \]
5.2 \[ V_o = -R_f \left( \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} \right) \]
\[ = -15 \times 10^3 \left( \frac{1.2}{4 \times 10^3} + \frac{1}{6 \times 10^3} + \frac{0.8}{8 \times 10^3} \right) \]
\[ = -8.5V \] (3) [15]

**QUESTION 6**

6.1  Figure 2  Triac
Figure 3  Light activated SCR
Figure 4  Diac
Figure 5  Quadrac (4 x 2) (8)
6.2

<table>
<thead>
<tr>
<th>Open-loop system</th>
<th>Closed-loop system</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No comparator</td>
<td>There is a comparator</td>
</tr>
<tr>
<td>2. No feedback</td>
<td>There is feedback</td>
</tr>
<tr>
<td>3. Manually operated</td>
<td>Automatically operated</td>
</tr>
<tr>
<td>4. Unmonitored</td>
<td>Monitored</td>
</tr>
</tbody>
</table>

(3 x 2) (6)

6.3 False

(1) [15]

QUESTION 7

7.1 A transducer is a device that converts non-electrical physical parameters into electrical signals.

(2)

7.2 Force

Pressure

(2)

7.3

- If there is no pressure applied to the active gauge, the bridge will be balanced and the output in the galvanometer will be zero.

- If pressure is applied in the active gauge, the bridge will be out of balance due to the change in length and thus in the area and resistance and the change can be read in a galvanometer.

- The compensation gauge will prevent false observation due to temperature variations.

(3) [10]
QUESTION 8

8.1 8.1.1 Time/div (Time base control) - Controls the rate at which the spot travels across the screen.

8.1.2 Vertical position - Moves the trace up or down for easier measurement or observation.

8.1.3 Intensity - Determines the brightness of the spot on the display.

8.1.4 Horizontal position - Moves the trace left or right for easier measurement or observation.

8.1.5 Volts/div - Adjusts the amplitude of the waveform.

8.2 Electrostatic deflection
Electromagnetic deflection

8.3
\[
t = \frac{1}{f}
\]

\[
= \frac{1}{8000}
\]

= 125 µs

t = scale setting x width

width = \frac{t}{scale \ setting}

= \frac{125 \times 10^{-6}}{50 \times 10^{-6}}

= 2.5 cm

TOTAL: 100