NATURAL SCIENCE MARKING GUIDELINES

August 2011
INDUSTRIAL ELECTRONICS N3
8080613

Augustus 2011
INDUSTRIËLE ELEKTRONIKA N3
SECTION A

QUESTION 1

1.1.1 F
1.1.2 T
1.1.3 T
1.1.4 T
1.1.5 F
1.1.6 T
1.1.7 T
1.1.8 T
1.1.9 T
1.1.10 T

(10)

1.2.1 A
1.2.2 R
1.2.3 C
1.2.4 A
1.2.5 A
1.2.6 B
1.2.7 D
1.2.8 D
1.2.9 A
1.2.10 B

(10)

TOTAL SECTION A: 20
SECTION B

QUESTION 2

2.1 2.1.1 Loop LUKPQRS L

\[ 20 = I_1 + I_2 + 5(0.062) - 3(I_2 - 0.062) + 4I_1 \]
\[ = I_1 + I_2 + 0.310 - 3I_2 + 0.186 + 4I_1 \]
\[ 19.504 = 5I_1 - 2I_2 \] \[ \text{[1]} \]

2.1.2 Loop LUTSL

\[ 20 = I_1 + I_2 + 2(I_1 + I_2 - 0.062) + 4I_1 \]
\[ = I_1 + I_2 + 2I_1 + 2I_2 - 0.124 + 4I_1 \]
\[ 20,124 = 7I_1 + 3I_2 \] \[ \text{[2]} \]

2.1.3 \[ [1] \times 3 : 58,512 = 15I_1 - 6I_2 \] \[ \text{[3]} \]
\[ [2] \times 2 : 40,248 = 14I_1 + 6I_2 \] \[ \text{[4]} \]
\[ [3] + [4] : 98,760 = 29I_1 \]
\[ I_1 = 3,406A \]

Substitute / SteL \[ I_{st} = 3,406A \] in [1]

\[ 19,504 = 5(3,406) - 2I_2 \]
\[ = 17,030 - 2I_2 \]
\[ 2,474 = -2I_2 \]
\[ \therefore I_2 = -1,237A \]

2.2 2.2.1 Forced commutation \( \checkmark \)

Line commutation \( \checkmark \)

2.2.2 Forced commutation is a method used in which a current is 'forced' to flow in a direction opposite to the forward conducting current. Is used in DC circuits

Line commutation is accomplished whenever the alternating current signal crosses zero from positive to negative, the anode becomes negative with respect to the cathode and the SCR will turn off. Is used in AC circuits

2.3 2.3.1 Static control. \( \checkmark \)

2.3.2 Cyclotronic control \( \checkmark \)

2.3.3 Phase control \( \checkmark \)

2.3.4 Cycle control \( \checkmark \)
QUESTION 3

3.1 3.1.1
\[ X_L = \frac{2\pi fL}{2\times \pi \times 50 \times 0.05} = 15,708 \Omega \]  (1)

3.1.2
\[ X_C = -\frac{1}{2\pi fC} = \frac{1}{2\times \pi \times 50 \times 800 \times 10^{-6}} = 3,978 \Omega \]  (1)

3.1.3
\[ Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{5^2 + (15,708 - 3,978)^2} = 12,753 \Omega \]  (2)

3.1.4
\[ I = \frac{V}{Z} = \frac{220}{12,753} = 17,251 \text{A} \]  (1)

3.1.5
\[ Z_{RL} = \sqrt{R^2 + (X_L)^2} = \sqrt{5^2 + (15,708)^2} = 16,486 \Omega \]  (2)

\[ V_{RL} = I \times Z_{RL} = 17,251 \times 16,486 = 284,4V \]

OR

\[ V_R = IR = 17,251 \times 5 = 86,255V \]
\[ V_L = I \times X_L = 17,251 \times 15,708 = 271,013V \]
\[ V_{RL} = \sqrt{V_R^2 + V_L^2} = 284,4V \]  (✓)

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3.4 3.4.1 The SCR is normally turned on by injecting a pulse of current into the gate terminal. This would cause current to flow from the anode to the cathode.

Once the SCR is turned on, the gate loses control over the device. Further gate pulses will not affect the conduction of the device. The SCR will continue to conduct (even with no gate current) for as long as the current flowing through it remains above the holding current.

3.4.2 In the absence of any gate current, a small leakage current flows. If the voltage applied to the anode is now increased to such an extent that the SCR's breakover voltage is reached, avalanche breakdown occurs and regenerative feedback occurs and the SCR turns on.

[16]
4.1 4.1.1 Class A amplifier

\[ V_{\text{ceq}} = \frac{1}{2} V_{\text{cc}} \]

\[ V_{\text{cc}} = 20\,\text{V} \checkmark \]

4.1.2 \[ I_{\text{cq}} = \frac{1}{2} I_c \]  

\[ I_c = 5\,\text{mA} \checkmark \]

4.1.3 \[ R_c = \frac{V_{\text{cc}}}{I_c} \]

\[ = \frac{20\,\text{V}}{5\,\text{mA}} = 4\,\text{k}\Omega \checkmark \]

4.2

\[ I_c = \frac{V_{\text{cc}}}{R_c} \]

\[ V_{\text{ce}} = V_{\text{cc}} \]

\[ 10\,\text{V} \]

\[ 20\,\text{V} \]

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4.4 Relatively unaffected by radiation ✓
No offset voltage when used as a switch ✓
Very high input resistance ✓
Considerable thermal stability ✓
Less noisy than bipolar transistors ✓
Small gain-bandwidth

Any five

QUESTION 5

5.1.1

5.1.2 By positioning the slider with an external source, the resistance varies in a potentiometer.

5.1.3 Barometers, humidity monitors, angular displacement meters ✓

5.2 Physical quantity to be measured ✓
Accuracy required ✓
Converting principle which is most suitable ✓
5.3

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>ADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>High input impedance</td>
<td>Small size</td>
</tr>
<tr>
<td>Low output impedance</td>
<td>Cheap</td>
</tr>
<tr>
<td>High voltage gain</td>
<td>Low power consumption</td>
</tr>
<tr>
<td>Wide bandwidth</td>
<td>Highly stable</td>
</tr>
<tr>
<td>Its parameters are matched and track</td>
<td>Highly reliable</td>
</tr>
<tr>
<td>well with temperature changes</td>
<td></td>
</tr>
<tr>
<td>Can handle ac and DC</td>
<td></td>
</tr>
</tbody>
</table>

ANY THREE                     ANY THREE

(6)

QUESTION 6

6.1

![Diagram of signal processing](image)

\( \frac{1}{2} \) mark for label
\( \frac{1}{2} \) mark for arrow in right direction
\( \frac{1}{2} \) correct

6.2 The cathode ray tube (CRT) produces a sharply focused beam of electrons and accelerates it to a very high velocity to strike the fluorescent screen with enough energy to light up in a small spot.  

(2)

6.3 6.3.1

![LED symbol](image)

\( \frac{1}{2} \) mark for labelling "anode"
\( \frac{1}{2} \) mark for labelling "cathode"
1 mark for LED symbol

(2)

6.3.2

![Characteristic curve](image)

\( \frac{1}{2} \) mark for labelling \( I \) in mA
\( \frac{1}{2} \) mark for labelling \( V \) axis in volts
\( \frac{1}{2} \) mark for \( I \) axis scale
\( \frac{1}{2} \) mark for \( V \) axis scale
1 mark for characteristic curve

(3)

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1 mark for LED symbol
1 mark for photodiode symbol

TOTAL SECTION B: 80
GRAND TOTAL: 100
INDUSTRIAL ELECTRONICS N3

FORMULA SHEET

Direct-current theory

\[ V = I \cdot R \]

\[ P = V \cdot I \]

\[ P = I^2 \cdot R \]

Alternating current theory:

\[ X_l = 2\pi f L \]

\[ X_C = \frac{1}{2\pi f C} \]

\[ Z = \sqrt{R^2 + (X_l - X_C)^2} \]

\[ V_t = \sqrt{V_R^2 + (V_i - V_c)^2} \]

\[ I = \frac{V_t}{Z} \]

\[ \theta = \cos^{-1} \frac{R}{Z} \]

\[ V = I \cdot R \]

\[ V = I \cdot X_i \]

\[ V = I \cdot X_c \]

\[ f_r = \frac{1}{2\pi \sqrt{LC}} \]

\[ I_R = \frac{V_t}{R} \]

\[ I_L = \frac{V_t}{X_l} \]

\[ I_c = \frac{V_t}{X_c} \]

\[ I_t = \sqrt{I_R^2 + I_X^2} \]

\[ I_X = I_t - I_c \]

\[ \theta = \tan^{-1} \frac{I_X}{I_R} \]

\[ \theta = \cos^{-1} \frac{I_t}{I_t} \]

\[ Z = \frac{V}{I_t} \]

\[ Z_d = \frac{L}{RC} \]

\[ I_T = \frac{V}{Z_d} \]

\[ f_r = \frac{1}{2\pi \sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}} \]

\[ I_c = I_{RL} \sin \theta_l \]

\[ I_t = I_{RL} \cos \theta_l \]

\[ I_t = \sqrt{I_{th}^2 + I_{ty}^2} \]

Transistors:

\[ I_c = \frac{V_{OC}}{R_t} \]

Transducers:

\[ R = \frac{D \cdot L}{a} \]

\[ C = \frac{k \cdot A \cdot E_o}{d} \]