Marking Scheme

Exam Paper
BSc CE

Logic Circuits (630211)

Final Exam Second semester Date: 02/06/2019
Section 1
Weighting 40% of the module total

Lecturer: Dr. Qadri Hamarsheh
Coordinator: Dr. Qadri Hamarsheh
Internal Examiner: Dr. Naser Halasa
Marking Scheme
Logic Circuits (630211)

The presented exam questions are organized to overcome course material through 6 questions. The all questions are compulsory requested to be answered.

Marking Assignments

**Question 1** This question is attributed with 10 marks if answered properly; the answers are the following:

1) The binary number 11101011000111010 can be written in hexadecimal as ________.
   a) DD63A<sub>16</sub>      b) 1D63A<sub>16</sub>
   c) 1D631<sub>16</sub>        d) 1D33A<sub>16</sub>

2) Refer to the following figure. If A = 0 and B = 1, what will be the logic states at X, Y and Z?
   a) X=1, Y=1, Z=0  b) X=1, Y=0, Z=0
   c) X=0, Y=0, Z=1  d) X=0, Y=1, Z=0

3) The simplification of the Boolean expression (\(\overline{A}B\overline{C}\) + \(A\overline{B}C\)) is
   a) 0  b) 1  c) A  d) BC

4) The equivalent canonical (standard) form for the following logical expression
   \(F = AB + C\) is
   a) \(F = ABC + \overline{ABC} + \overline{ABC} + \overline{ABC}\)
   b) \(F = ABC + \overline{ABC} + \overline{ABC} + \overline{ABC}\)
   c) \(F = ABC + \overline{ABC} + \overline{ABC} + \overline{ABC} + \overline{ABC}\)
   d) None of the above

5) The function \(F(A, B, C) = \sum(1, 2, 3, 5, 7)\) is equivalent to
   a) \(\overline{C} + \overline{AB}\)  b) \(C + AB\)
   c) \(C + \overline{AB}\)  d) \(C + AB\)

6) Which of the following circuits come under the class of combinational logic circuits?

   Select the correct answer from the codes given below:
   a) 1 only  b) 3 and 4  c) 4 and 5  d) 1, 2, and 3

7) The Boolean function realized by the logic circuit shown is
   a) \(F = \Sigma m \{0, 1, 3, 5, 9, 10, 14\}\)  b) \(F = \Sigma m \{2, 3, 5, 7, 8, 12, 13\}\)
   c) \(F = \Sigma m \{1, 2, 4, 5, 11, 14, 15\}\)  d) \(F = \Sigma m \{2, 3, 5, 7, 8, 9, 12\}\)

8) The circuit shown here is most likely a ________.
   a) Adder  b) Multiplexer  c) Demultiplexer  d) Parity generator
9) If the input combination \( A=0, B=1 \) is applied to this circuit, the (steady state) output will be:

- a) \( X=0, Y=0 \)
- b) \( X=0, Y=1 \)
- c) \( X=1, Y=0 \)
- d) \( X=1, Y=1 \)

10) The characteristic equation for the T-Flip Flop is:

- a) \( Q(t+1) = T \cdot \overline{Q} + \overline{T} \cdot Q \)
- b) \( Q(t+1) = \overline{T} \cdot \overline{Q} + T \cdot Q \)

**Question 2** This question is attributed with 6 marks if answered properly; the answers are the following:

**a)**

**Solution**

**Three weighted Binary codes codes are:**

1. BCD (8421)
2. 6311
3. 2421
4. 642-3
5. 84-2-1

**b)**

**Solution**

\[ D = (\overline{A}B + \overline{C})(A + C) = \overline{A}B(A + C) = ([A + \overline{B}C](A + C) = (A + \overline{B})(AC + C) = A + AC + \overline{AB} + BC = AC + AC + BC(A + 1) = AC + BC(1) = AC + BC = (A + \overline{B})C \]

**c)**

**Solution**

\[ D = A(B + \overline{B}) + (A + \overline{A})BC = AB + \overline{A}B + A\overline{BC} + \overline{A}BC \]

\[ D = AB(C + \overline{C}) + A\overline{B}(C + \overline{C}) + A\overline{BC} + \overline{A}BC \]

\[ = ABC + AB\overline{C} + A\overline{BC} + A\overline{BC} + A\overline{BC} + \overline{A}BC \]

\[ = \overline{ABC} + AB\overline{C} + A\overline{BC} + ABC + \overline{AC} + ABC \]

\[ = m_1 + m_4 + m_5 + m_6 + m_7 = \Sigma(1, 4, 5, 6, 7) \]
Question 3

This question is attributed with 7 marks if answered properly; the answers are the following:

(a) (4 marks)

Solution

\[
\begin{align*}
S &= C_{in} \oplus (X \oplus Y) \\
C_{out} &= C_{in} \cdot (X \oplus Y) + XY
\end{align*}
\]

Proof:

The sum:

\[
S = XYC_{in} + X\overline{Y}C_{in} + XYC_{in} + XYC_{out}
\]

\[
= C_{in}(XY + XY) + C_{in}(X \overline{Y} + XY)
\]

\[
= C_{in}(XY) + C_{in}(X \overline{Y} + XY)
\]

\[
S = C_{in} \oplus (X \oplus Y)
\]

The carry output:

\[
C_{out} = \overline{X}YC_{in} + X\overline{Y}C_{in} + XYC_{in} + XYC_{out}
\]

\[
= C_{in}(XY + XY) + C_{in}(X \overline{Y} + XY)
\]

\[
= C_{in}(XY + XY) + C_{in}(X \overline{Y} + XY)
\]

\[
= C_{in}(XY) + C_{in}(X \overline{Y} + XY)
\]

\[
C_{out} = C_{in} \cdot (X \oplus Y) + XY
\]

(b) (3 marks)

Solution

<table>
<thead>
<tr>
<th>CHARACTERISTIC EQUATION</th>
<th>EXCITATION TABLE</th>
</tr>
</thead>
</table>
| \( Q_{(next)} = S + R'Q \) | \begin{align*}
Q &\quad Q_{(next)} &\quad S &\quad R \\
0 &\quad 0 &\quad 0 &\quad X \\
0 &\quad 1 &\quad 1 &\quad 0 \\
1 &\quad 0 &\quad 0 &\quad 1 \\
1 &\quad 1 &\quad X &\quad 0
\end{align*} |

\( SR = 0 \)

<table>
<thead>
<tr>
<th>CHARACTERISTIC EQUATION</th>
<th>EXCITATION TABLE</th>
</tr>
</thead>
</table>
| \( Q_{(next)} = JQ' + K'Q \) | \begin{align*}
Q &\quad Q_{(next)} &\quad J &\quad K \\
0 &\quad 0 &\quad 0 &\quad X \\
0 &\quad 1 &\quad 1 &\quad X \\
1 &\quad 0 &\quad X &\quad 1 \\
1 &\quad 1 &\quad X &\quad 0
\end{align*} |
Question 4 This question is attributed with 7 marks if answered properly; the answers are the following:

**Solution**

### a) (3 marks)

**Solution**

\[ \text{F}_1 = (X + Z) + XYZ = X'Z' + XYZ = X'Z'(Y + Y') + XYZ = X'Y'Z' + X'YZ' + XYZ = m_0 + m_2 + m_7 \]

\[ \text{F}_2 = (X + Z) + X'YZ = X'Z' + XYZ = X'Z'(Y + Y') + X'YZ = X'Y'Z' + X'YZ' + XYZ = m_0 + m_2 + m_3 \]

\[ \text{F}_3 = XY'Z + (X + Z) = XY'Z + X'Z' = XY'Z + X'Z(Y + Y') = XY'Z + X'Y'Z' + XYZ = m_5 + m_0 + m_2 \]

### b) (2 marks)

**Solution**

### c) (2 marks)

**Solution**
Question 5 This question is attributed with 5 marks if answered properly; the answers are the following:

**Solution**

a) **(1.5 marks)**

![Logic Circuit Diagram](image1)

b) **(2 marks)**

<table>
<thead>
<tr>
<th>Present State</th>
<th>Inputs</th>
<th>Next State</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>A  B</td>
<td>x  y</td>
<td>A  B</td>
<td>z</td>
</tr>
<tr>
<td>0  0</td>
<td>0  0</td>
<td>0  0</td>
<td>0</td>
</tr>
<tr>
<td>0  0</td>
<td>0  1</td>
<td>1  0</td>
<td>0</td>
</tr>
<tr>
<td>0  0</td>
<td>1  0</td>
<td>0  0</td>
<td>0</td>
</tr>
<tr>
<td>0  0</td>
<td>1  1</td>
<td>0  0</td>
<td>0</td>
</tr>
<tr>
<td>0  1</td>
<td>0  0</td>
<td>0  1</td>
<td>1</td>
</tr>
<tr>
<td>0  1</td>
<td>0  1</td>
<td>1  1</td>
<td>1</td>
</tr>
<tr>
<td>0  1</td>
<td>1  0</td>
<td>0  0</td>
<td>1</td>
</tr>
<tr>
<td>0  1</td>
<td>1  1</td>
<td>0  0</td>
<td>1</td>
</tr>
<tr>
<td>1  0</td>
<td>0  0</td>
<td>0  0</td>
<td>0</td>
</tr>
<tr>
<td>1  0</td>
<td>0  1</td>
<td>1  0</td>
<td>0</td>
</tr>
<tr>
<td>1  1</td>
<td>0  0</td>
<td>1  1</td>
<td>0</td>
</tr>
<tr>
<td>1  1</td>
<td>0  1</td>
<td>1  1</td>
<td>0</td>
</tr>
<tr>
<td>1  1</td>
<td>0  0</td>
<td>0  1</td>
<td>1</td>
</tr>
<tr>
<td>1  1</td>
<td>0  1</td>
<td>1  1</td>
<td>1</td>
</tr>
<tr>
<td>1  1</td>
<td>1  0</td>
<td>1  1</td>
<td>1</td>
</tr>
<tr>
<td>1  1</td>
<td>1  1</td>
<td>1  1</td>
<td>1</td>
</tr>
</tbody>
</table>

c) **(1.5 marks)**

![State Machine Diagram](image2)
**Question 6** This question is attributed with 5 marks if answered properly; the answers are the following:

**Solution**

<table>
<thead>
<tr>
<th>Present State</th>
<th>Input</th>
<th>Next State</th>
<th>Flip-Flop Inputs</th>
<th>Q(t)</th>
<th>Q(t+1)</th>
<th>J</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>A  B  x</td>
<td>A  B</td>
<td>J_A K_A J_B K_B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0  0  0</td>
<td>0  0  0  X  0  X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0  0  1</td>
<td>0  1  0  X  1  X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0  1  0</td>
<td>1  0  1  X  X  1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0  1  1</td>
<td>0  1  0  X  X  0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1  0  0</td>
<td>1  0  X  0  0  X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1  0  1</td>
<td>1  1  X  0  1  X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1  1  0</td>
<td>1  1  X  0  X  0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1  1  1</td>
<td>1  0  X  1  X  1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(2 marks)

(2 marks)

(1 mark)