Solution - EE 2173 Exam 1

Oct. 8, 2009

Multiple Choices (10 points): Circle one correct answer (2 pts each).

1. (b) The development cycle for an FPGA is much shorter.

2. (d) 8

3. (d) Accuracy

4. (b) 4, 3

5. (d) \([-2^{n-1}, 2^{n-1}-1]\)

Short Answer (10 points): 5pts each

6. The CMOS circuit has lower power dissipation in static state than the PMOS or NMOS only implementations, so it is more energy efficient. The price we pay for this advantage is that the number of transistors is doubled with the CMOS implantation as compared with the PMOS or NMOS only implementation.

7. For any given input combination, if the corresponding output of two logic function is identical, they have functional equivalence. One simple way to prove functional equivalence of two logic functions is to use truth table. Two logic functions with identical truth table can be proved as Functionally Equivalent.

Quantitative Problems (80 points)

8. (6)

<table>
<thead>
<tr>
<th>Decimal</th>
<th>Binary</th>
<th>Octal</th>
<th>Hexadecimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>08</td>
<td>b01000</td>
<td>o10</td>
<td>0x8</td>
</tr>
<tr>
<td>09</td>
<td>b01001</td>
<td>o11</td>
<td>0x9</td>
</tr>
<tr>
<td>10</td>
<td>b01010</td>
<td>o12</td>
<td>0xA</td>
</tr>
<tr>
<td>11</td>
<td>b01011</td>
<td>o13</td>
<td>0xB</td>
</tr>
<tr>
<td>12</td>
<td>b01100</td>
<td>o14</td>
<td>0xC</td>
</tr>
<tr>
<td>13</td>
<td>b01101</td>
<td>o15</td>
<td>0xD</td>
</tr>
<tr>
<td>14</td>
<td>b01110</td>
<td>o16</td>
<td>0xE</td>
</tr>
<tr>
<td>15</td>
<td>b01111</td>
<td>o17</td>
<td>0xF</td>
</tr>
<tr>
<td>16</td>
<td>b10000</td>
<td>o20</td>
<td>0x10</td>
</tr>
<tr>
<td>17</td>
<td>b10001</td>
<td>o21</td>
<td>0x11</td>
</tr>
<tr>
<td>18</td>
<td>b10010</td>
<td>o22</td>
<td>0x12</td>
</tr>
<tr>
<td>19</td>
<td>b10011</td>
<td>o23</td>
<td>0x13</td>
</tr>
</tbody>
</table>
9. (15)

(a) Unsigned integer: \(2^7+2^6+2^5+2^2+1 = 229\)

(b) Sign and Magnitude: - (2^6+2^5+2^2+1) = -101

(c) 1's Complement: - (0011010) = - (2^4+2^3+2^1) = -26

(d) 2's Complement: - (0011011) = -27

(e) BCD: 95

(Correction: use b10010101 for part (e))

10. (5)

(a) Binary: 245 = 2^7+2^6+2^5+2^4+2^2+2^0 = b11110101

(b) Octal: 11,110,101 = o365

(c) Hex: 1111,0101 = 0XF5

11. (8)

(a) 
\[
\begin{array}{cccccc}
1 & 0 & 1 & 0 & 1 & 0 \\
+ & 0 & 1 & 1 & 1 & 0 \\
\hline
1 & 0 & 0 & 1 & 0 & 0
\end{array}
\]

(no overflow: since there is a carry into the sign bit, there is also a carry out of sign bit.)

(b) B – C = B + ( -C)
\[
\begin{array}{cccccc}
0 & 1 & 1 & 1 & 1 & 0 \\
+ & 0 & 0 & 0 & 0 & 1 \\
\hline
1 & 0 & 0 & 0 & 0 & 1
\end{array}
\]

(overflow occur: since there is a carry into the sign bit, while there is no carry out of sign bit)

12. (8)

(a) N x P: convert the negative number, multiply and convert the result.
\[
\begin{array}{c}
0100 \\
0011
\end{array}
\]
\[
\begin{array}{c}
0100 \\
0100
\end{array}
\]
\[
01100 \text{ -> } 10011+1 = 10100 \text{ (-12)}
\]

(b) NxN: convert both numbers and multiply
\[
\begin{array}{c}
0011 \\
0101
\end{array}
\]
\[
\begin{array}{c}
0011 \\
0011
\end{array}
\]
\[
001111 \text{ (+15)}
\]
13. (8)
If there is 3 check bits, the data bits can be covered is $2^3-1-3=4$, not sufficient.
If there is 4 check bits, the data bits can be covered is $2^4-1-4=11$, sufficient.

$$d_9 C_8 d_7 d_6 d_5 C_4 d_3 C_2 C_1$$
1 __ 0 1 0 __ 1 __ __.

$x$ $x$ $x$ $x$ $x$ $x$ $x$ $x$ $C_1 = 0$

$x$ $x$ $x$ $x$ $x$ $x$ $x$ $x$ $C_2 = 0$

$x$ $x$ $x$ $x$ $x$ $x$ $x$ $x$ $C_4 = 1$

Therefore, the hamming code with check bits of this 5-bit data is: 110101100, and the overall parity bit is 1. Hence, the final result is 110101100 + 1

14. (8)

<table>
<thead>
<tr>
<th>X1</th>
<th>X2</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>$f$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>on</td>
<td>on</td>
<td>off</td>
<td>off</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>on</td>
<td>off</td>
<td>off</td>
<td>on</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>off</td>
<td>on</td>
<td>on</td>
<td>off</td>
<td>0</td>
</tr>
<tr>
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<td>1</td>
<td>off</td>
<td>on</td>
<td>on</td>
<td>on</td>
<td>0</td>
</tr>
</tbody>
</table>

15. (22) (a)

$$f = A'B'C'D' + A'B'CD' + A'BC'D' + A'BCD' + AB'C'D' + AB'CD' + AB'CD$$
(b) $f_{sop} = B'D' + A'D' + AB'C$

<table>
<thead>
<tr>
<th>cd</th>
<th>00</th>
<th>01</th>
<th>11</th>
<th>10</th>
</tr>
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<tbody>
<tr>
<td>ab</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>00</td>
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<td>1</td>
</tr>
<tr>
<td>01</td>
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<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>11</td>
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<tr>
<td>10</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

(c)