UNIVERSITY OF CALIFORNIA, RIVERSIDE

Department of Computer Science and Engineering
Department of Electrical Engineering
CS/EE120A – Logic Design
Midterm 1
February 1, 2001

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Name: Solution Key **Student ID#:**_____
Please print legibly

Lab Section: 21 (MW 3-6):_____ **22** (TR 2-5):_____ **23** (MF 8-11):_____

(Numbers in parenthesis denote total possible points for question.)

1. Use Boolean algebra (i.e. use the theorems to manipulate the expression) to convert the function $F(x,y,z) = \Sigma(2,3,4)$ to its product of maxterms form. (4)

Answer

$F(x,y,z) = \Sigma(2,3,4)$
$= m_2 + m_3 + m_4$
$= x'yz' + x'yz + xy'z'$
$= \cancel{(x' + x' + x)}\ (x' + x' + y')\ (x' + x' + z')$
$\cancel{(x' + y + x)}\ \cancel{(x' + y + y')}\ (x' + y + z')$
$\cancel{(x' + z + x)}\ (x' + z + y')\ \cancel{(x' + z + z')}$
$\cancel{(y + x' + x)}\ \cancel{(y + x' + y')}\ (y + x' + z')$
$(y + y + x)\ \cancel{(y + y + y')}\ (y + y + z')$
$(y + z + x)\ \cancel{(y + z + y')}\ \cancel{(y + z + z')}$
$\cancel{(z' + x' + x)}\ (z' + x' + y')\ (z' + x' + z')$
$(z' + y + x)\ \cancel{(z' + y + y')}\ (z' + y + z')$
$\cancel{(z' + z + x)}\ \cancel{(z' + z + y')}\ \cancel{(z' + z + z')}$
$= (x' + y' + z)\ (x' + y' + z')\ (x' + y + z')$
$(x + y + z)\ (x + y + z')$
$= M_0 \bullet M_1 \bullet M_5 \bullet M_6 \bullet M_7$
$= \Pi(0,1,5,6,7)$

2. Use Boolean algebra to proof that if $F(x,y,z) = \Sigma(2,3,4)$, then $F'(x,y,z) = \Pi(2,3,4)$ (4)

Answer

$$
\begin{aligned}
F'(x,y,z) &= (\Sigma(2,3,4))' \\
&= (m_2 + m_3 + m_4)' \\
&= (x'yz' + x'yz + xy'z')' \\
&= (x'yz')' \bullet (x'yz)' \bullet (xy'z')' \\
&= (x + y' + z) \bullet (x + y' + z') \bullet (x' + y + z) \\
&= M_2 \bullet M_3 \bullet M_4 \\
&= \Pi(2,3,4)
\end{aligned}
$$

3. Use Boolean algebra to simplify as much as possible the following function: (4)

$$F = w'x'y'z' + w'x'y'z + w'xy'z' + w'xy'z + wxyz + wxyz' + wx'yz + wx'yz'$$

Answer

$$\begin{aligned} F &= w'x'y'z' + w'x'y'z + w'xy'z' + w'xy'z + wxyz + wxyz' + wx'yz + wx'yz' \\ &= w'y'(x'z' + x'z + xz' + xz) + wy(x'z' + x'z + xz' + xz) \\ &= w'y'(1) + wy(1) \\ &= w \odot y \end{aligned}$$

4. Perform the following calculations in binary arithmetic. Write your answer in binary, octal, and hexadecimal: (8)

$$\begin{array}{rr} & 10011 \\ & 01010 \\ + & 00111 \\ \hline \end{array}$$

$$\begin{array}{rr} & 01010 \\ - & 00111 \\ \hline \end{array}$$

$$\begin{array}{rr} & 11011 \\ * & 10101 \\ \hline \end{array}$$

$$1011\overline{)\,1001011101}$$

Answer

```
   10011
   01010
+  00111
  100100
```

44_8 24_{16}

```
   01010
-  00111
   00011
```

3_8 3_{16}

```
      11011
*     10101
      11011
     00000
    11011
   00000
+ 11011
 1000110111
```

1067_8 237_{16}

```
       110111
1011) 1001011101
       1011
        1111
        1011
         10011
          1011
          10000
           1011
             1011
             1011
                0
```

67_8 37_{16}

5. Perform the following calculation in 5-bit 2's complement representation. What is the answer in decimal? (4)

$$\begin{array}{r} 10011 \\ 01010 \\ +\ 10111 \\ \hline \end{array}$$

Answer

$$\begin{array}{r} 10011 \\ 01010 \\ +\ 10111 \\ \hline \cancel{1}10100 \end{array}$$

since we are using 5-bit, the overflow bit is ignored, therefore,
$10100 = -12_{10}$

6. Using AND, OR, and NOT gates, draw the circuit diagram that realizes the following truth table. Do not simplify. (6)

x	*y*	*z*	*F*
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

Answer