ELEN 21 HW #2

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Question #1:

X3 X4 \ X1 X2	00	01	11	10
00	1	1	0	0
01	1	1	0	1
11	0	0	1	1
10	0	1	1	0

(a) Generate the corresponding truth table

x_1	x_2	x_3	x_4	f
0	0	0	0	1
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	0
1	1	1	0	1
1	1	1	1	1

Table 1: Truth table of the K-map

(b) Identify all the prime implicants, expressing them as product terms.

Prime Implicants: $\overline{X_1}\cdot\overline{X_3}\cdot\overline{X_4}$, $\overline{X_1}\cdot\overline{X_2}\cdot\overline{X_3}$, $\overline{X_3}\cdot X_4\cdot\overline{X_1}$, $\overline{X_1}\cdot X_2\cdot\overline{X_3}$, $X_2\cdot X_3\cdot\overline{X_4}$, $X_1\cdot X_2\cdot X_3$, $X_2\cdot X_3\cdot X_4$, $X_1\cdot\overline{X_2}\cdot X_4$, $\overline{X_1}\cdot X_2\cdot\overline{X_4}$, $\overline{X_3}\cdot X_4\cdot\overline{X_2}$

(c) Identify which of the prime implicants are essential

Essential Prime Implicants: $\overline{X_1} \cdot \overline{X_3} + X_2 \cdot X_3 \cdot \overline{X_4} + X_1 \cdot X_3 \cdot X_4 + X_1 \cdot \overline{X_2} \cdot X_4$

(d) If it were determiend that a value of X_1, X_2, X_3, X_4 equal to 0111 were not possible, what would the K-map look like?

X3 X4 \ X1 X2	00	01	11	10
00	1	1	0	0
01	1	1	?	1
11	0	0	1	1
10	0	1	1	0

(e) Assuming the change in (d), what would appear to be the simplest algebraic expression of this function?

Assuming the changes in (d) make the value of 0111 to be a "don't-care" value, we can determine the algebraic expression of the function to be:

$$\sum SOP = \overline{X_1} \cdot \overline{X_3} + X_2 \cdot X_3 + X_1 \cdot X_2 \cdot \overline{X_4}$$

Question #2:

Using this truth table:

X1X2X3X4	F
0000	1
0001	1
0010	1
0011	1
0100	0
0101	0
0110	1
0111	1
1000	1
1001	1
1010	0
1011	1
1100	1
1101	1
1110	1
1111	1

(a) Draw the corresponding K-map

	00	01	11	10
00	1 0	1 1	1 3	1 2
01	0 4	0 5	1 7	1 6
11	1 12	1 13	1 15	1 14
10	1 8	1 9	1 11	0 10

(b) After identifying the prime implicants, what would be the apparently simplest SOP equation that implements this function?

$$\sum SOP = \overline{X_2} \cdot \overline{X_3} + \overline{X_1} \cdot X_3 + X_1 \cdot X_2 + X_1 \cdot X_4$$

(c) Now look at the 0s in the map, and identify a simpler solution.

$$\sum POS = (\overline{X_1} + X_2 + \overline{X_3} + X_4) \cdot (X_1 + \overline{X_2} + X_3)$$

Question #3:

Given the following truth table:

X1X2X3	F
000	0
001	1
010	0
011	1
100	1
101	0
110	1
111	1

If we were to apply Shannon's expansion and use X_2 as a mux select, we could define two 2-input truth tables. Let's call these sub-functions F_0 and F_1.

(a) Generate the truth tables for F_0 and F_1

x_2	x_1	x_3		f
0	0	0	F_0	0
	0	1		1
	1	0		1
	1	1		0
1	0	0	F_1	0
	0	1		1
	1	0		1
	1	1		1

Table 2: Two truth tables after Shannon's Expansion

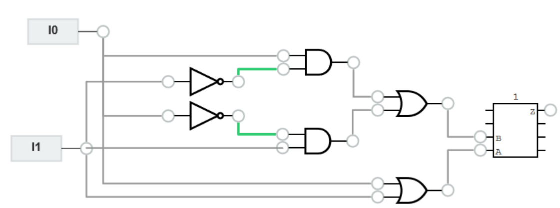
(b) Expression F_0 and F_1 as algebraic equations that are functions of X_1 and X_3.

We can see that F_0 is an XOR function and F_1 is an OR function.

$$F_0 = X_1 \cdot \overline{X_3} + \overline{X_1} \cdot X_3$$

$$F_1 = X_1 + X_3$$

(c) Draw a logic circuit that shows the generation of F_0 and F_1 feeding into a mux that uses x_2 as the mux select, thus implementing the complete function f



(d) Now determine what the circuit would look like if you used a 4:1 mux using x_2 and x_3 as the mux selects.