ECE 230 Practice Exam #1 **Solutions**

1. Convert the decimal number $(40)_{10}$ to binary.

40 ÷ 2 = 20 rem 0 (LSb)
20 ÷ 2 = 10 rem 0
10 ÷ 2 = 5 rem 0
5 ÷ 2 = 2 rem 1
2 ÷ 2 = 1 rem 0
1 ÷ 2 = 0 rem 1 (MSb)

Answer: $(101000)_2$

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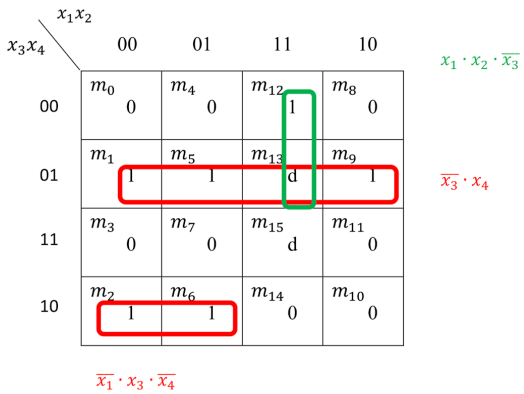
5. Find the minimum sum-of-products (SOP) implementation for $f(x_1, x_2, x_3, x_4) = \sum m(1, 2, 5, 6, 9, 12) + D(13, 15)$.

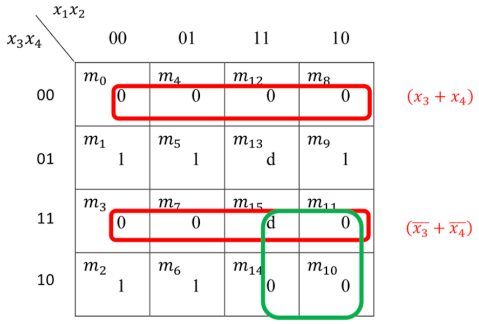


$x_1 \cdot x_2 \cdot \overline{x_3}$

$\overline{x_3} \cdot x_4$

$\overline{x_1} \cdot x_3 \cdot \overline{x_4}$

6. Find the minimum product-of-sums (POS) implementation for $f(x_1, x_2, x_3, x_4) = \sum m(1, 2, 5, 6, 9) + D(13, 15)$.



$(x_3 + x_4)$

$(\overline{x_3} + \overline{x_4})$

$(\overline{x_1} + \overline{x_3})$

This is one of two possible solutions. Can you identify the other?

Answer: $f(x_1, x_2, x_3, x_4) = (x_3 + x_4) \cdot (\overline{x_3} + \overline{x_4}) \cdot (\overline{x_1} + \overline{x_3})$

7. Perform the following operations involving eight-bit 2's complement numbers and indicate whether arithmetic overflow occurs (circle yes or no.)

A

01100001 ← carry bits
00110001
+ 01101001
10011010

Note that we added to positive numbers and got a negative result → Overflow

Overflow: Yes No

Answer: $(10011010)_2$

B

00110010 → 01000101 ← carry bits
− 01000101 → + 10111011
11101101

Negative of 01000101 found via invert all bits (10111010) and then add 1 → 10111011

Overflow: Yes No

Answer:

s (A, B, and C) below, indicate the value of the expression (0 or 1.) binary value.

) ⊕ 1) + 0

0 = 0 + 0 = 0

+ 0 + x

0 · x

Answers:

f = 0

g = x

h = 0

WHEN PRODUCT OF SUMS, FLIP THE SIGN OVER IT. ^^^^IF THERE IS AN EVEN NUMBER OF 1's IT IS 0. IF THERE ARE AN ODD AMOUNT OF 1's IT IS 1.

3.5. The results of the operations are:

(a):	00110110	54	(b):	01110101	117	(c):	11011111	(-33)
	+01000101	+69		+11011110	− 34		+10111000	+(−72)
	01111011	123		01010011	83		10010111	(−105)
(d):	00110110	54	(e):	01110101	(117)	(f):	11010011	(−45)
	−00101011	−43		−11010110	−(− 42)		−11101100	−(−20)
	00001011	11		10011111	(159)		11100111	(−25)

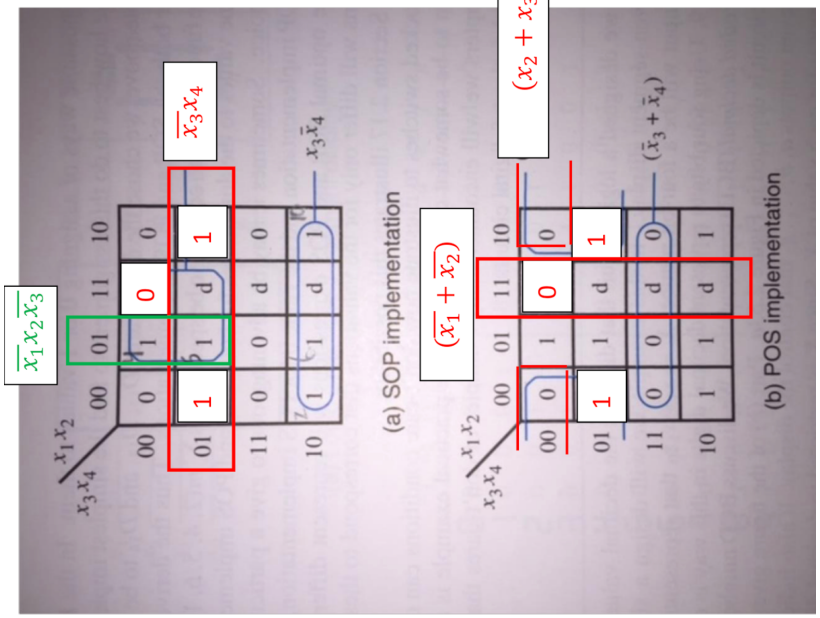
The simplest SOP implementation of the function is

$$\begin{aligned} f &= \overline{x}_1\overline{x}_2x_3 + \overline{x}_1x_2x_3 + x_1\overline{x}_2\overline{x}_3 + x_1x_2\overline{x}_3 + x_1x_2x_3 \\ &= \overline{x}_1(\overline{x}_2 + x_2)x_3 + x_1(\overline{x}_2 + x_2)\overline{x}_3 + (\overline{x}_1 + x_1)x_2x_3 \\ &= \overline{x}_1x_3 + x_1\overline{x}_3 + x_2x_3 \end{aligned}$$

SOP: As is figure below $f(x_1,x_2,x_3,x_4) = x_3\overline{x_4} + \overline{x_3}x_4 + \overline{x_1}x_2\overline{x_3}$

Or alternatively (not shown) $f(x_1,x_2,x_3,x_4) = x_3\overline{x_4} + \overline{x_3}x_4 + \overline{x_1}x_2\overline{x_4}$

POS: As is figure below $f(x_1,x_2,x_3,x_4) = (\overline{x_1} + \overline{x_2})(\overline{x_3} + \overline{x_4})(x_2 + x$



The simplest POS implementation of the function is

$$\begin{aligned} f &= (x_1 + x_2 + x_3)(x_1 + \overline{x}_2 + x_3)(\overline{x}_1 + x_2 + \overline{x}_3) \\ &= ((x_1 + x_3) + x_2)((x_1 + x_3) + \overline{x}_2)(\overline{x}_1 + x_2 + \overline{x}_3) \\ &= (x_1 + x_3)(\overline{x}_1 + x_2 + \overline{x}_3) \end{aligned}$$