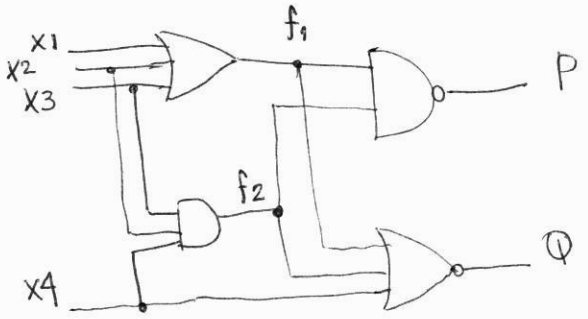
Nathalia Peixoto
ECE 331.

HOMEWORK 4

② inputs : $X1, X2, X3, X4$
outputs : P, Q



$f_1 = X1 + X2 + X3$

$f_2 = X2\,X3\,X4$

$$Q = \overline{f_1 + f_2 + X4}$$

$$\boxed{Q = \overline{(X1 + X2 + X3) + (X2X3X4)} + X4}$$

$$P = \overline{f_1 f_2}$$

$$\boxed{P = \overline{(X1 + X2 + X3).(X2X3X4)}}$$

$$P = \overline{X1 + X2 + X3} + \overline{(X2X3X4)}$$

$$\boxed{P = (\overline{X1}\,\overline{X2}\,\overline{X3}) + \overline{(X2X3X4)}}$$

Truth table

X1 X2 X3 X4	P	Q
0000	1	1
0001	1	0
0010	1	0
0011	1	0
0100	1	0
0101	1	0
0110	1	0
0111	0	0
1000	1	0
1001	1	0
1010	1	0
1011	1	0
1100	1	0
1101	1	0
1110	1	0
1111	0	0

P

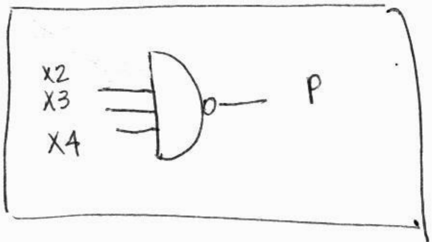
X3 X4 \ X1X2	00	01	11	10
00				
01				
11		0	0	
10				

(easier to write the maxterm!)

$$P = \overline{X2} + \overline{X3} + \overline{X4}$$

$$\overline{\overline{P}} = \overline{\overline{\overline{X2} + \overline{X3} + \overline{X4}}}$$

$$P = \overline{X2 \cdot X3 \cdot X4}$$



Q

X3X4 \ X1X2	00	01	11	10
00	1			
01				
11				
10				

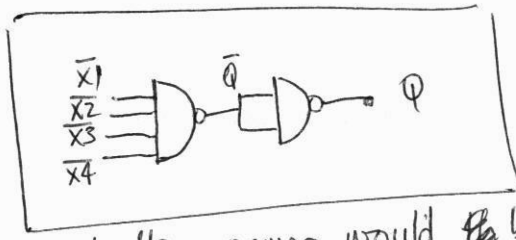
(easier to write the minterm!

$$Q = \overline{X1}\,\overline{X2}\,\overline{X3}\,\overline{X4}$$

POS:

$$\overline{\overline{Q}} = \left(\overline{\overline{\overline{X1}\,\overline{X2}\,\overline{X3}\,\overline{X4}}}\right)$$

$$Q = \overline{\overline{\overline{X1}} + \overline{\overline{X2}} + \overline{\overline{X3}} + \overline{\overline{X4}}}$$

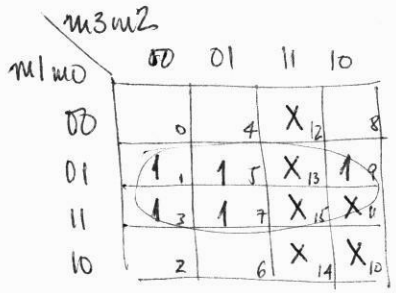


Obs. A better answer would be to show [inverter] for all inputs!

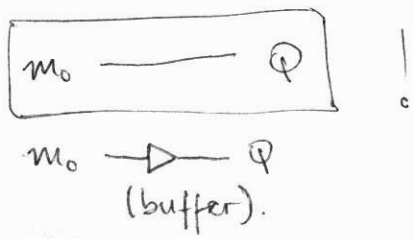
(3) INPUTS: m_3, m_2, m_1, m_0. Output: Q

a)

BCD	m_3	m_2	m_1	m_0	ODD?
0	0	0	0	0	0
1	0	0	0	1	1
2	0	0	1	0	0
3	0	0	1	1	1
4	0	1	0	0	0
5	0	1	0	1	1
6	0	1	1	0	0
7	0	1	1	1	1
8	1	0	0	0	0
9	1	0	0	1	1



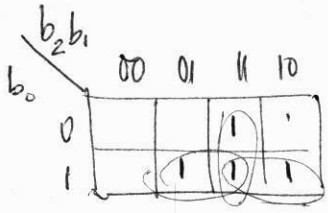
$Q = m_0$



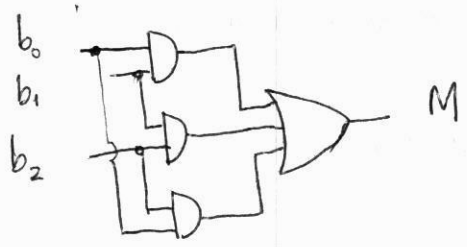
b) ① Inputs: b_2, b_1, b_0

Output: M

b_2	b_1	b_0	P
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1



$M = b_2b_1 + b_1b_0 + b_2b_0$



(4) a) x+y

x*y

x/y

x+y

```
 01110010
    11100
 --------
 00001110
```

~~**x*y**~~

~~01110010~~
~~11100~~
~~0111001000~~
~~01110010~~
~~1010101110000~~

WRONG! do it again!

x/y = 100

```
        100.
11100 ) 01110010
        11100
         000 10
```

↑ Remainder

b) **x+y = 0101101.**

```
 0101010
     011
 -------
 0101101
```

x*y = 0111110

```
  0101010
      011
  -------
  0101010
 0101010
 --------
 0111110
```

x/y = 1110

```
      1110
011 ) 0101010
     - 011
        100
        011
        0011
         011
        0000
```

here, again

```
      01110010
         11100
  ------------
  0111001000
  01110010
 01110010
 -------------
 1100011110000
```

5. $X = -102$ $Y = 32$

Ⓐ

$102_{10} = 01100110$

$-102_{10} = 10011001$ (1's)

$-102_{10} = 10011010$ (2's)

$32_{10} = 00100000_2 = $ (1's = 2's!)

Because it's a positive number!

$X + Y$

```
  10011010
+ 00100000
----------
  10111010
```

$X - Y$

```
      (10) ← OVERFLOW!
-102   10011010
-32    11100000
-134  (1)01111010
       ↑
      CARRY
```

Ⓑ

$X = -96$ $Y = -37$

$96 = 01100000_2$

$X = -96 = (10011111)_2$ (1's)

$-96 = (10100000)_2$ (2's)

$X = -37$

$37_{10} = (00100101)_2$

$-37_{10} = (11011010)_2$ (1's)

$-37 = (11011011)_2$ (2's)

$X + Y$

```
  (10) OVERFLOW!
   10100000
 + 11011011
 ----------
 (1)01111011
```

⇨ Note that this number is -133 (if you "allow" for 9 bits)

$X - Y$

```
  00
  10100000
 -00100101
 ---------
  11000101
```

⇨ What is this number?

2's c. → 00111011

→ $1 + 2 + 8 + 16 + 32 = 59$

It's -59

(C) $X = -96$

$96 = 01100000_2$

$-96 = 10011111_2$ (1's)

$-96 = 10100000$ (2's)

$Y = 15$

$= 00001111$ (same in 1's and 2's complement!)

$X + Y$

$$\begin{array}{r} 10100000 \\ + \ 00001111 \\ \hline 10101111 \end{array}$$

Which number?

2's ↓

01010001

$= 1 + 16 + 64 = 81$

$X - Y$

$-15 = 11110001$ (2's complement, so I can "add" both numbers!)

$$\begin{array}{r} (111) \\ 10100000 \\ 11110001 \\ \hline (1)10010001 \end{array}$$

THERE IS NO OVERFLOW!

IGNORE! ← (1)

This is the result!

→ (2's): $01101111 = 64 + 32 + 15 = 111$.

The result equals -111. (in decimal)

(D) $X = 77$

$77 = 01001101$

(1's comp, 2's comp)

$Y = 56$

$56 = 00111000$

(1's compl, 2's comp)

$X + Y = 77 + 56$

$$\begin{array}{r} (01)\ 1\ 1\ 1\ 1 \\ 01001101 \\ + \ 00111000 \\ \hline 10000101 \end{array}$$

OVERFLOW! ← (01)

What is this number!?

Positive – 9 bit – is ...

↳ $1 + 4 + 128 = 133$

$X - Y = 77 - 56$

$-56 = 11001000$ (2's compl)

$$\begin{array}{r} (1\ 1) \\ 01001101 \\ + \ 11001000 \\ \hline (1)00010101 \end{array}$$

NO OVERFLOW! ← (11)

IGNORE ← (1)

↓

$1 + 4 + 16 = 21$

(E) $X = 12$

00001100

(1's, 2's) ...

$Y = -25$

$25 = 00011001$

(1's) $-25_{10} = 11100110_2$

(2's) $-25_{10} = 11100111_2$

$X + Y = 12 - 25$

00001100
11100111

11110011

2's

00001101

13

result is -13.

$X - Y = 12 + 25$

00001100
00011001

00100101

$= 1 + 4 + 32 = 37.$

(F) $X = -95$

$95 = 01011111$

$-95 = 10100000$ (1's)

$-95 = 10100001$ (2's)

$Y = -47$

$47 = 00101111$

$-47 = 11010000$ (1's)

$-47 = 11010001$ (2's)

$X + Y = -95 - 47$

OVERFLOW! (10)

1010 0001
1101 0001
---
(1) 0111 0010

8 bits

010001110

$= 2 + 4 + 8 + 128$

$= 142$

(so it would have 9 bit result)

$X - Y = -95 + 47$

NO OVERFLOW

1010 0001
0010 1111

1101 0000

2's

0011 0000

(16 + 32 = 48)

$(-48)_{10}$

this number is ...

(G) X = 37

37 = 00100101

(1's and 2's are the same)

X + Y =
37 + 48

0010 0101
0011 0000

0101 0101

= 1 + 4 + 16 + 64 = 85

Y = 48

48 = 00110000

(1's = 2's comp).

-48 = 11010000 (2's)

X - Y = 37 - 48

0010 0101
+ 1101 0000

11110101

to find the decimal representation of this number:

00001011 → 11

(-11)

6) EXTRA CREDIT

X+Y

-96 → 10011111

15 → 00001111

01010110

(1)

CARRY IS ZERO,
SO RESULT IS RIGHT!

(10101110) ← is 01010001 1's

1+16+64 = 81.

-81

X+Y

-96 10011111

-15 11110000

CARRY 1 10001111

\+ 1

10010000

This is a negative number in 1's complement representation

Which number?

$(01101111)_2 =$

$= (64+32+8+4+2+1)_{10}$

$96+15$

$= (111)_{10}$