Homework 1 - John Akujobi

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EE244 Fall 2022 Homework 1

Number Systems and Digital Logic Gates

Due: Wednesday, Aug. 31 before class to D2L

1. Order a DE10 Lite board or obtain from another student in the EE/CS department

   Deliverable: Mr. Galipeau will get a list of who ordered through the form. If you bought from another student, write that here and bring it to lab on Tuesday to be checked off.

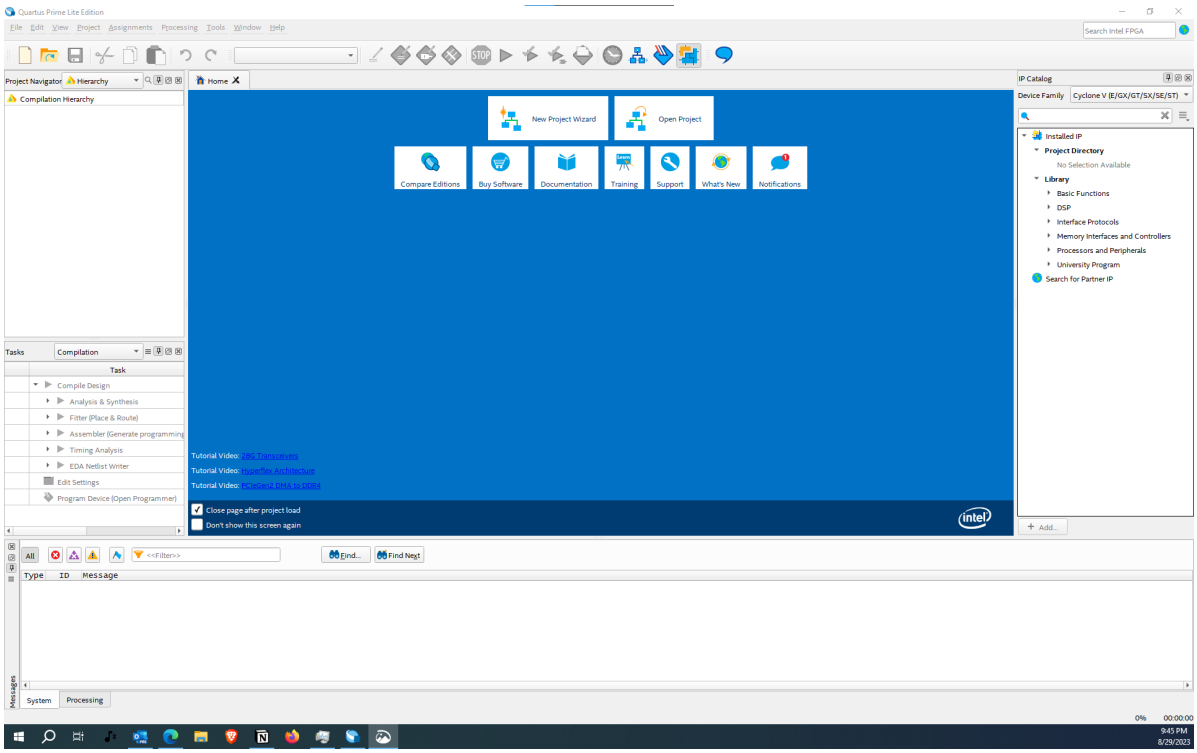
2. Download and install Intel Quartus Prime Lite

   Download Intel Quartus Prime Lite v21.1 **Combined Files**

   https://fpgasoftware.intel.com/?edition=lite

   Additional set up instructions will be available on the lab D2L page

   Deliverable: a screenshot of the software loaded on your computer.4gt



Write the binary representations of the decimal numbers 0 through 15. These binary representations will be used frequently in this course. You should study them and look for patterns so that you can remember them easily.

Decimal	Binary
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

1.14a-c. Convert the following binary numbers into decimal (**show your work**):[1]

1. 1110

```
1110 base 2
= 1 * 2^3 + 1 * 2^2 + 1 * 2^1 + 0 * 2^0
= 8 + 4 + 2 + 0
= 14
```

2. 10 1100

```
10 1100 base 2
= 1 * 2^5 + 0 * 2^4 + 1 * 2^3 + 1 * 2^2 + 0 * 2^1 + 0 * 2^0
= 32 + 0 + 8 + 4 + 0 + 0
= 44
```

3. 1101 0011

```
= 1 * 2^7 + 1 * 2^6 + 0 * 2^5 + 1 * 2^4 + 0 * 2^3 + 0 * 2^2 + 1 * 2^1 +1*2^0
= 128 + 64 + 0 + 16 + 0 + 0 + 2 + 1
= 211
```

1.26a-c. Convert the following decimal numbers into binary (**show your work**):

1. 14

```
14 / 2 = 7 rem 0
7 / 2 = 3 rem 1
3 / 2 = 1 rem 1
```

```
1 / 2 = 0 rem 1
=> 1110
```

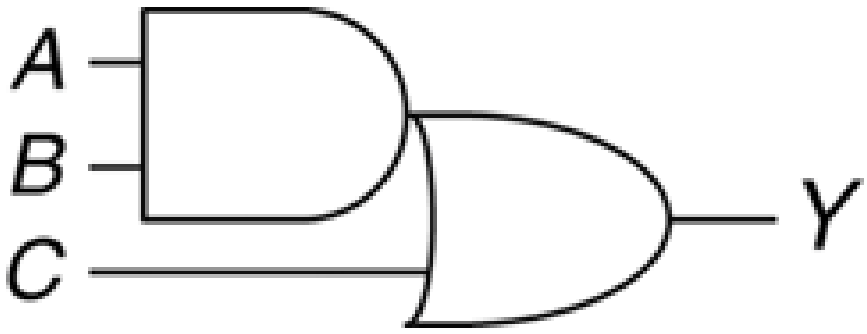
2. 50

```
50 / 2 = 25 rem 0
25 / 2 = 12 rem 1
12 / 2 = 6 rem 0
6 / 2 = 3 rem 0
3 / 2 = 1 rem 1
1 / 2 = 0 rem 1
=> 110010
```

3. 329

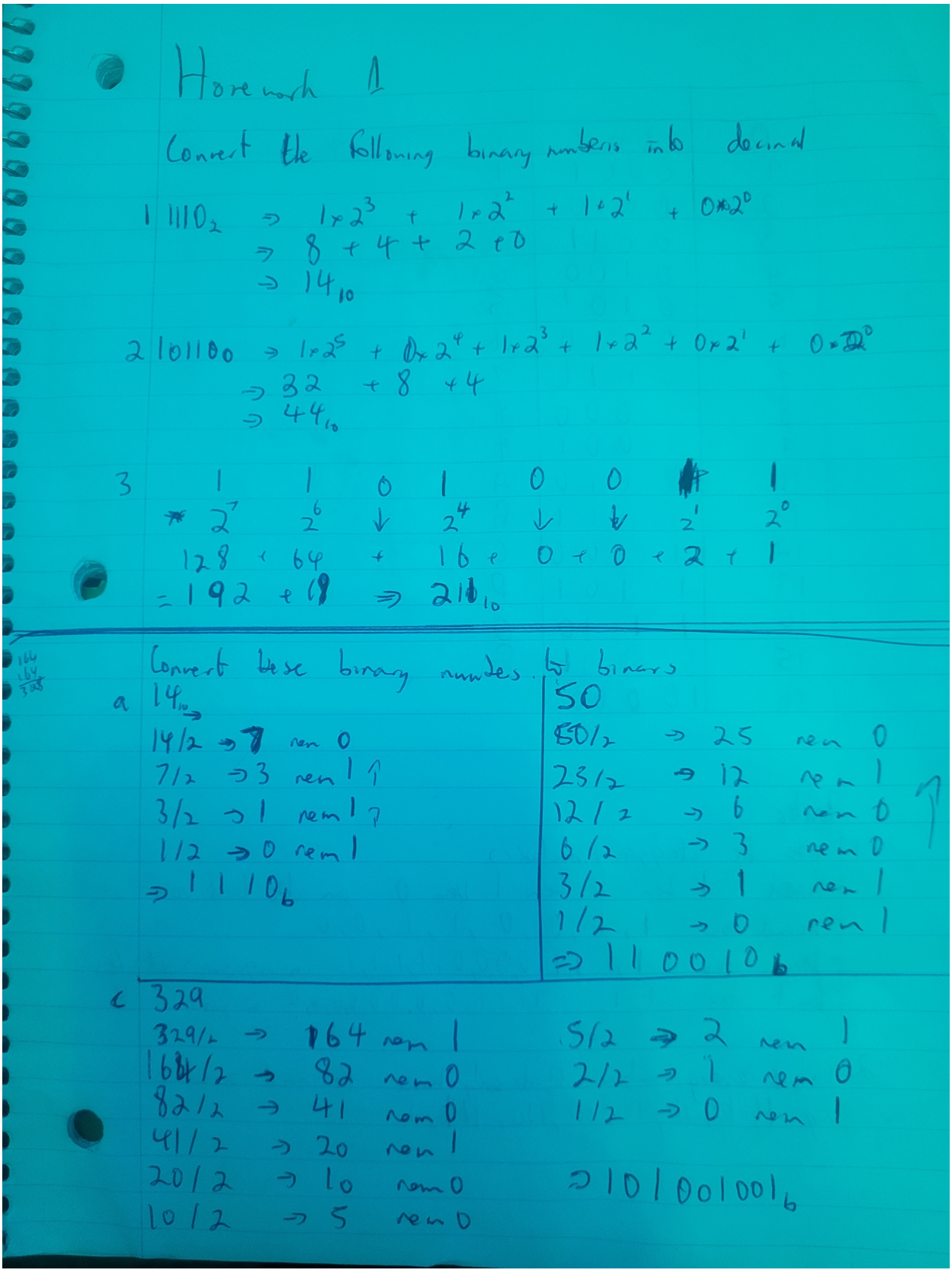
```
329 / 2 = 164 rem 1
164 / 2 = 82 rem 0
82 / 2 = 41 rem 0
41 / 2 = 20 rem 1
20 / 2 = 10 rem 0
10 / 2 = 5 rem 0
5 / 2 = 2 rem 1
2 / 2 = 1 rem 0
1 / 2 = 0 rem 1

=> 101001001
```

A three-input AND-OR gate produces a TRUE output if both A and B are TRUE, or if C is TRUE. Create a truth table for the gate (shown below) **using A as the most-significant bit** and **C as the least-significant bit**.



A	**B**	A.B	**C**	**Output**
0	0	0	0	0
0	0	0	1	1
0	1	0	0	0
0	1	0	1	1
1	0	0	0	0
1	0	0	1	1
1	1	1	0	1
1	1	1	1	1

Paper Version



Homework 1

Convert the following binary numbers into decimal

1 $1110_2 \Rightarrow 1\times2^3 + 1\times2^2 + 1\times2^1 + 0\times2^0$
$\Rightarrow 8 + 4 + 2 + 0$
$\Rightarrow 14_{10}$

2 $101100 \Rightarrow 1\times2^5 + 0\times2^4 + 1\times2^3 + 1\times2^2 + 0\times2^1 + 0\times2^0$
$\Rightarrow 32 + 8 + 4$
$\Rightarrow 44_{10}$

3

1	1	0	1	0	0	1	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	+ 64	+	16	+ 0	+ 0	+ 2	+ 1

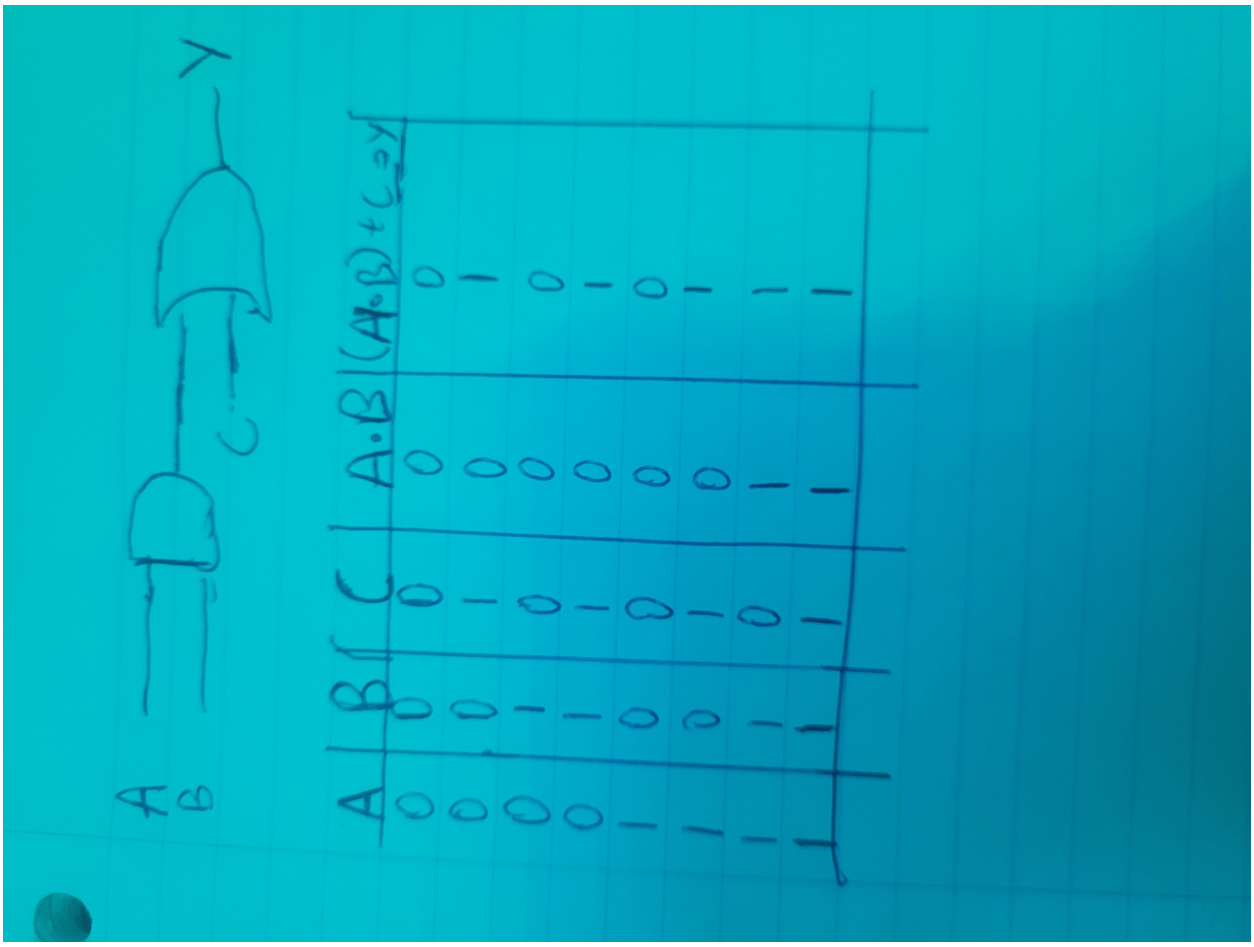
$= 192 + 19 \Rightarrow 211_{10}$

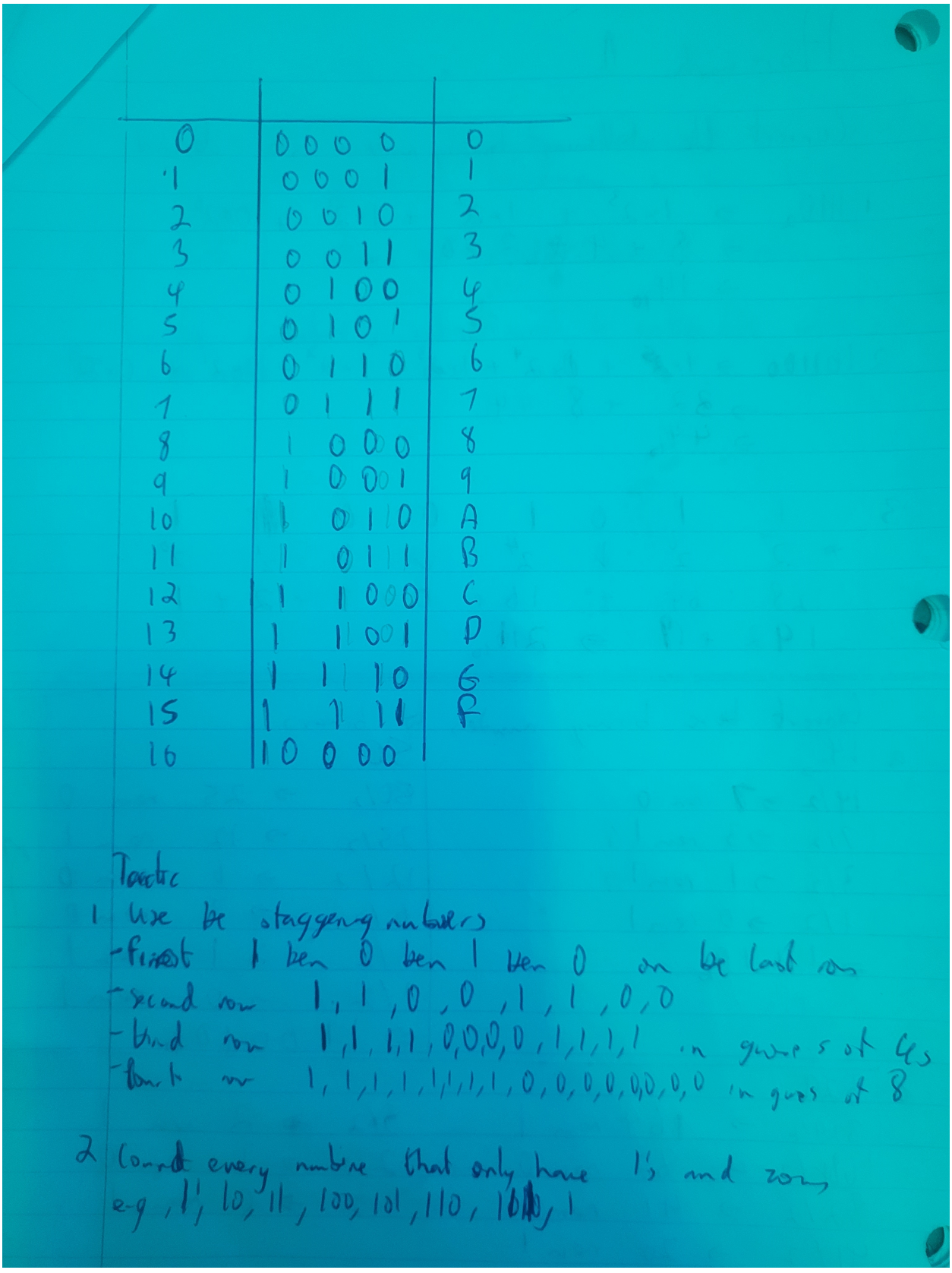
Convert these binary numbers to binary

a $14_{10} \Rightarrow$
14/2 → 7 rem 0
7/2 → 3 rem 1
3/2 → 1 rem 1
1/2 → 0 rem 1
$\Rightarrow 1110_b$

50
50/2 → 25 rem 0
25/2 → 12 rem 1
12/2 → 6 rem 0
6/2 → 3 rem 0
3/2 → 1 rem 1
1/2 → 0 rem 1
$\Rightarrow 110010_b$

c 329
329/2 → 164 rem 1
164/2 → 82 rem 0
82/2 → 41 rem 0
41/2 → 20 rem 1
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
$\Rightarrow 101001001_b$


Y
C
A
B
A | B | C | A·B | (A·B)+C = Y



0	0 0 0 0	0
1	0 0 0 1	1
2	0 0 1 0	2
3	0 0 1 1	3
4	0 1 0 0	4
5	0 1 0 1	5
6	0 1 1 0	6
7	0 1 1 1	7
8	1 0 0 0	8
9	1 0 0 1	9
10	1 0 1 0	A
11	1 0 1 1	B
12	1 1 0 0	C
13	1 1 0 1	D
14	1 1 1 0	E
15	1 1 1 1	F
16	10 0 0 0	

Tactic

1 Use the staggering numbers
- First 1 then 0 then 1 then 0 on the last row
- Second row 1, 1, 0, 0, 1, 1, 0, 0
- third row 1, 1, 1, 1, 0, 0, 0, 0, 1, 1, 1, 1 in groups of 4s
- fourth row 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0 in groups of 8

2 Count every number that only have 1's and zeros
e.g. 1, 10, 11, 100, 101, 110, 1000, 1