
04. BINARY SYSTEM
THE SECRET LANGUAGE OF COMPUTERS
M3U1P4

CAN COMPUTERS COUNT USING ONLY 0 AND 1?

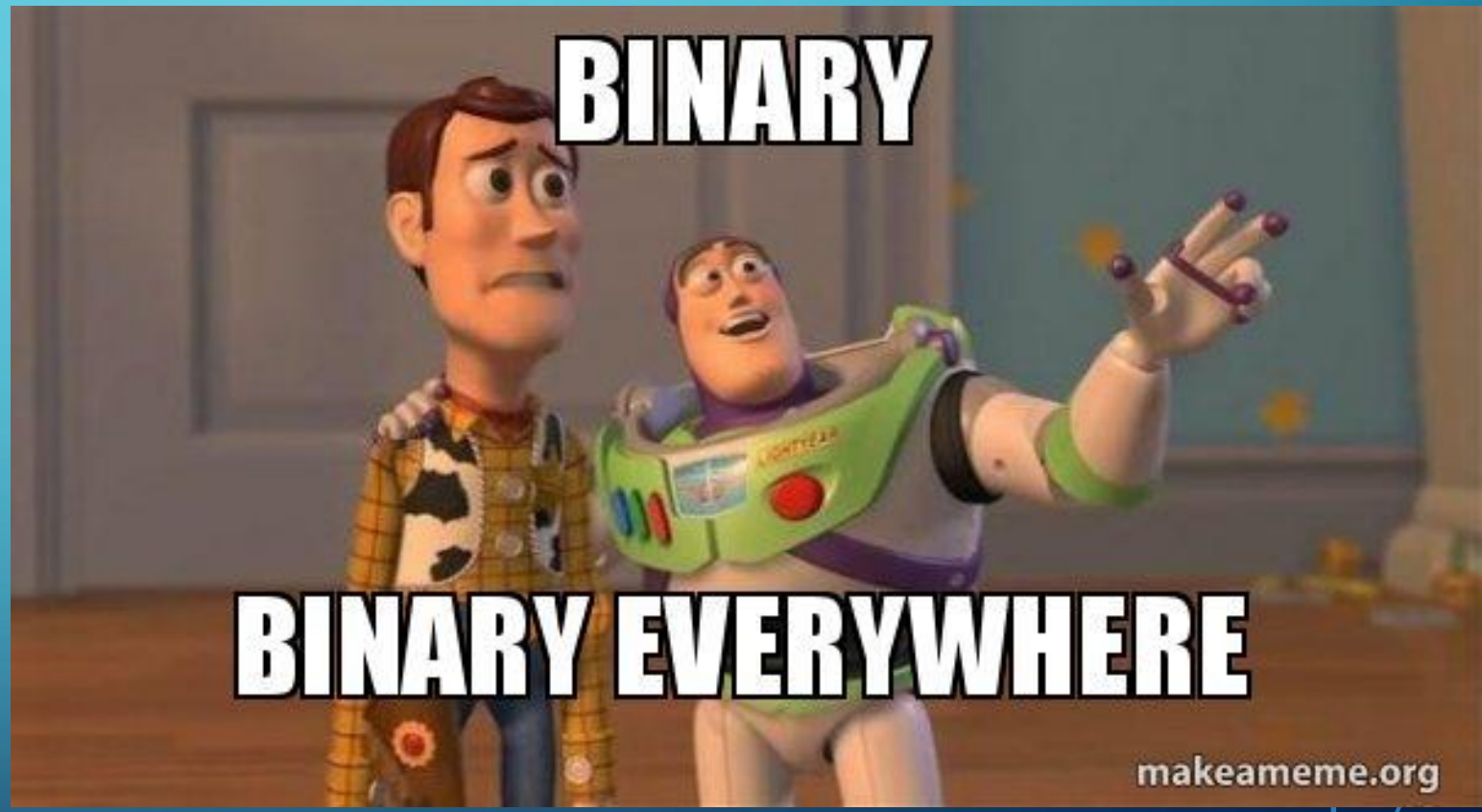
WHY DO YOU THINK COMPUTERS USE ONLY TWO NUMBERS?

WHY ONLY 0 AND 1?

- Computers Use Switches
- Computers are made from billions of tiny switches.
- Switch:
  - OFF = 0
  - ON = 1

BINARY IS EVERYWHERE

- Computers
- Phones
- game consoles
- QR codes
- digital images



WHAT IS A BINARY SYSTEM?

BINARY SYSTEM

- A **binary number** is a number expressed in the **base 2 numeral system** or **binary numeral system**
- It uses only two symbols
  - 0 (zero)
  - 1 (one)

BINARY SYSTEM

- Computers use binary, which means they store data and perform calculations using only 0s and 1s.
- A single binary digit can only show two values: true (1) or false (0) in Boolean logic.
- However, when many binary digits are combined, they can represent large numbers and allow computers to perform complex tasks.

CAN YOU SPOT THE PATTERN?

DECIMAL		BINARY
0	⟷	0 0 0 0

Decimal	Binary		Decimal	Binary
0	0		7	111
1	1		8	1000
2	10		9	1001
3	11		10	1010
4	100		64	1000000
5	101		256	100000000
6	110		1024	10000000000

HOW WILL NUMBERS 11-13 LOOK LIKE?

Decimal	Binary		Decimal	Binary
0	0		7	111
1	1		8	1000
2	10		9	1001
3	11		10	1010
4	100		11	?
5	101		12	?
6	110		13	?

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1	1		8	1000
2	10		9	1001
3	11		10	1010
4	100		11	1011
5	101		12	?
6	110		13	?

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5	101		12	1100
6	110		13	?

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1	1		8	1000
2	10		9	1001
3	11		10	1010
4	100		11	1011
5	101		12	1100
6	110		13	1101

CONVERTING FROM DECIMAL TO THE BINARY SYSTEM

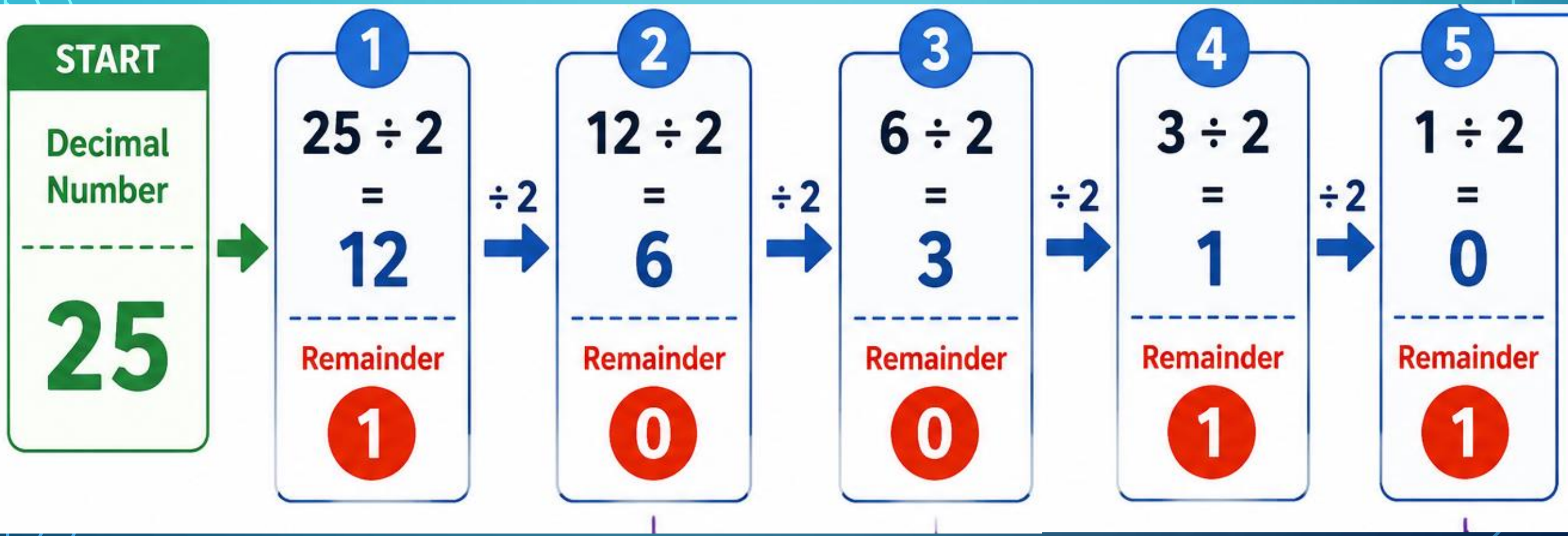
- How can we convert it?

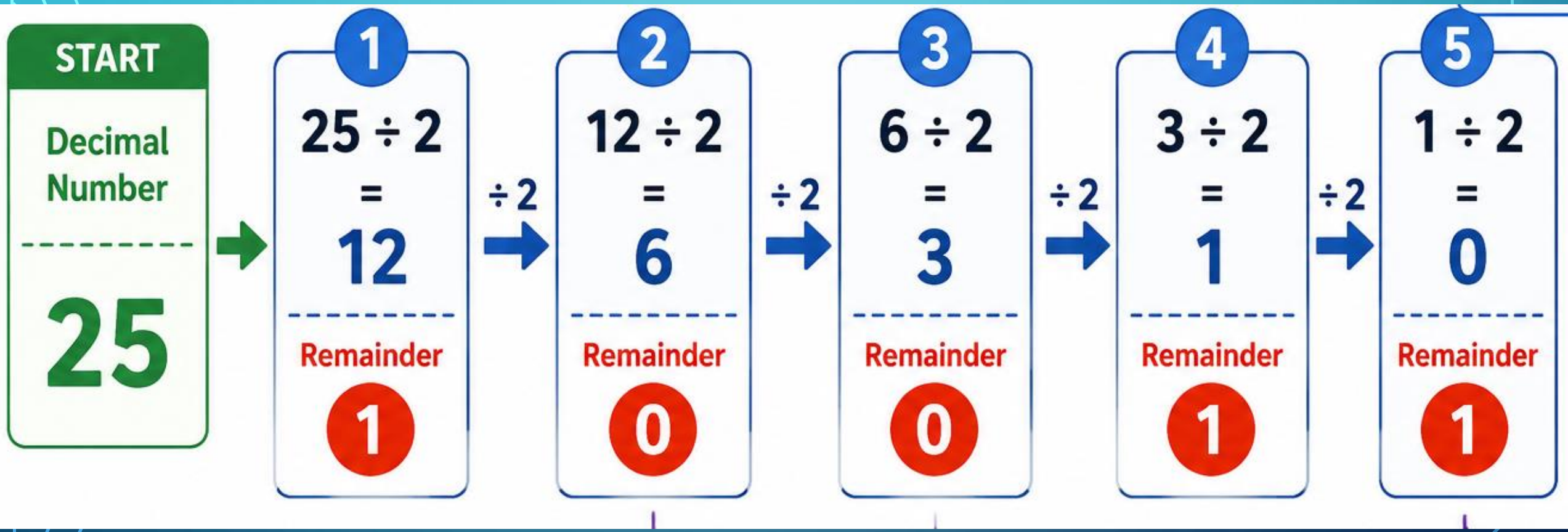
CONVERTING FROM DECIMAL TO THE BINARY SYSTEM

- Computers only use 0 and 1, so we need to change decimal numbers into binary numbers.
- The easiest way is to write the decimal number and keep dividing it by 2. Each time, you get a result and a remainder of either 0 or 1. Continue until the result becomes 0.

TASK 1

Convert 25 from decimal to binary.


START
Decimal Number
25
1
25 ÷ 2 = 12
Remainder 1
÷ 2
2
12 ÷ 2 = 6
Remainder 0
÷ 2
3
6 ÷ 2 = 3
Remainder 0
÷ 2
4
3 ÷ 2 = 1
Remainder 1
÷ 2
5
1 ÷ 2 = 0
Remainder 1


START
Decimal Number
25
1
25 ÷ 2 = 12
Remainder 1
÷2
2
12 ÷ 2 = 6
Remainder 0
÷2
3
6 ÷ 2 = 3
Remainder 0
÷2
4
3 ÷ 2 = 1
Remainder 1
÷2
5
1 ÷ 2 = 0
Remainder 1

CONVERT 25 TO BINARY

We divide by 2 and write down the **remainders**.

STEPS

1. Divide by 2
2. Note the remainder (0 or 1)

START

Decimal Number

25

	1	2	3	4	5
	25 ÷ 2 = 12	12 ÷ 2 = 6	6 ÷ 2 = 3	3 ÷ 2 = 1	1 ÷ 2 = 0
	÷2 →	÷2 →	÷2 →	÷2 →	÷2 →
Remainder	1	0	0	1	1

READ FROM BOTTOM TO TOP!

1 (top)
0
0
1
1 (bottom)

WRITE THE REMAINDERS FROM BOTTOM TO TOP → 1 1 0 0 1 = 11001_2

FINAL ANSWER

25 in decimal = **11001** in binary

Convert 25 to Binary

Start with decimal number

25

Steps: Divide by 2 and note the remainder.

1. $25 \div 2 = 12$ — Remainder **1**

Divide by 2

2. $12 \div 2 = 6$ — Remainder **0**

Divide by 2

3. $6 \div 2 = 3$ — Remainder **0**

Divide by 2

4. $3 \div 2 = 1$ — Remainder **1**

Divide by 2

5. $1 \div 2 = 0$ — Remainder **1**

Read from bottom to top!

Write the remainders from BOTTOM to TOP

$$11001_2$$

25 in decimal = **11001** in binary

TASK 2

Convert 156 from decimal to binary.

TASK 3

Convert 1234 from decimal to binary.

CONVERTING FROM BINARY TO THE DECIMAL SYSTEM

- How can we convert it?

CONVERTING FROM BINARY TO THE DECIMAL SYSTEM

- We can convert every binary number into a decimal number by using powers of 2.
- Each digit in a binary number has its own value. The value starts from the right side with the lowest value and increases as we move to the left.

Base 2 (Binary) Place Value Chart to Eight Places

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
2 x 64	2 x 32	2 x 16	2 x 8	2 x 4	2 x 2	2 x 1	1
128 One hundred twenty-eights place	**64** Sixty-fours place	**32** Thirty-twos place	**16** Sixteens place	**8** Eights place	**4** Fours place	**2** Twos place	**1** Ones place

EXAMPLE

Convert 10110 to decimal system

- What is the first thing that we need to do?

EXAMPLE

Convert 10110 to decimal system

- First, we must mark each of the numbers with their appropriate position

Position	?	?	?	?	?
Binary	1	0	1	1	0

EXAMPLE

Convert 10110 to decimal system

- First, we must mark each of the numbers with their appropriate position

Position	**?**	**?**	**?**	**?**	**0**
Binary	1	0	1	1	0

EXAMPLE

Convert 10110 to decimal system

- First, we must mark each of the numbers with their appropriate position

Position	**?**	**?**	**?**	**1**	**0**
Binary	1	0	1	1	0

EXAMPLE

Convert 10110 to decimal system

- First, we must mark each of the numbers with their appropriate position

Position	**?**	**?**	**2**	**1**	**0**
Binary	1	0	1	1	0

EXAMPLE

Convert 10110 to decimal system

- First, we must mark each of the numbers with their appropriate position

Position	**?**	**3**	**2**	**1**	**0**
Binary	1	0	1	1	0

EXAMPLE

Convert 10110 to decimal system

- First, we must mark each of the numbers with their appropriate position

Position	**4**	**3**	**2**	**1**	**0**
Binary	1	0	1	1	0

EXAMPLE

Convert 10110 to decimal system

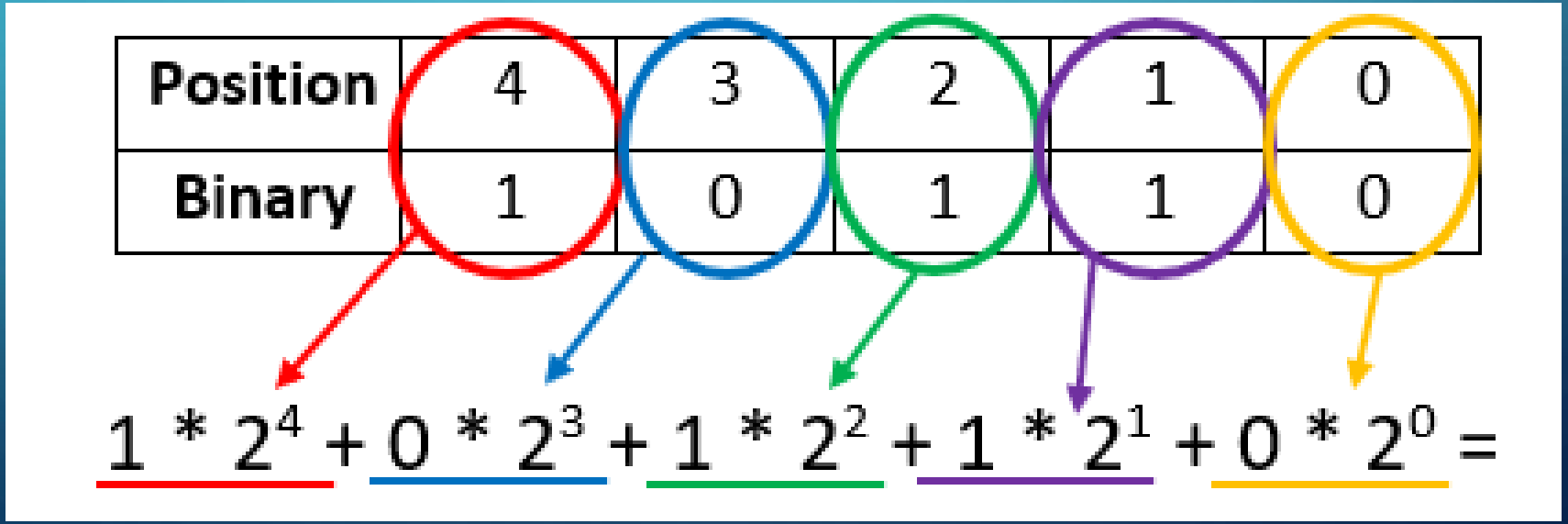
- What next?

Position	4	3	2	1	0
Binary	1	0	1	1	0

EXAMPLE

Convert 10110 to decimal system

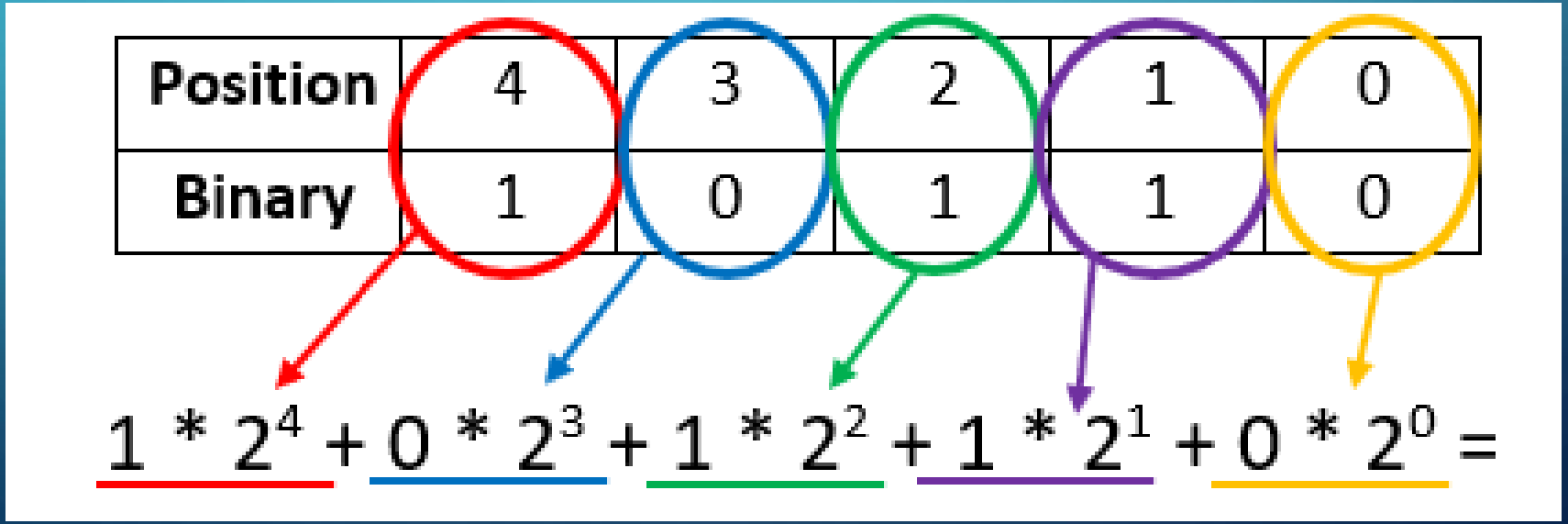
- After we have all the positions, we have to multiply with two on the power of that position



EXAMPLE

Convert 10110 to decimal system

- And the result is???



EXAMPLE

Convert 10110 to decimal system

Position	4	3	2	1	0
Binary	1	0	1	1	0

$$1 * 2^4 + 0 * 2^3 + 1 * 2^2 + 1 * 2^1 + 0 * 2^0 =$$

$$= 1 * 16 + 0 * 8 + 1 * 4 + 1 * 2 + 0 * 1 =$$

$$= 16 + 4 + 2 = 22$$

$$\mathbf{10110_{(2)} = 22_{(10)}}$$

TASK 4

Convert 10011 from binary to decimal.

TASK 5

Convert 011011011 from binary to decimal.

ANY QUESTIONS?

HOMEWORK

THE END