

# NUMBER SYSTEMS

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ICS<sub>3</sub>U  
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## What is a number system?

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How do we define it?

# Examples

- One digit
- Tally

1	I	6	I
2	II	7	II
3	III	8	III
4	IIII	9	IIII
5		10	

# Examples

- 7 Digits
- Roman Numerals

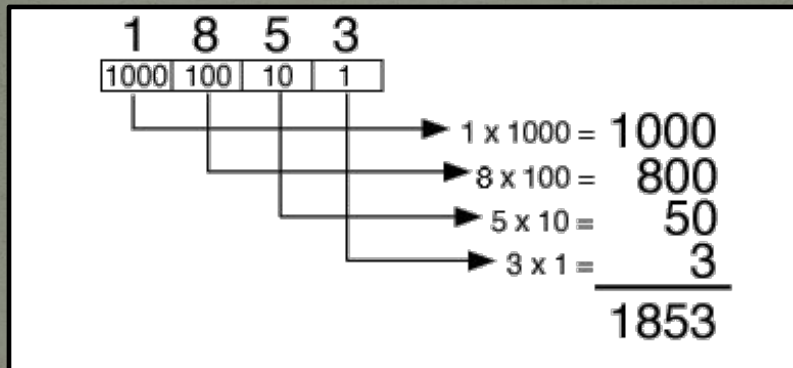
Symbol	Value
I	1
V	5
X	10
L	50
C	100
D	500
M	1000

A notepad showing the conversion of the Roman numeral MCMXXXIV to the decimal number 1934. The Roman numeral is written in red at the top. Below it, the symbols are broken down into their respective values: M (1000), CM (900), XXX (30), and IV (4). The calculation is shown as 1000 + 900 + 30 + 4 = 1934. A red pencil is shown pointing to the Roman numeral, and a black pencil is shown pointing to the final result.

MCMXXXIV  
| T T T  
1000 + 900 + 30 + 4  
= 1934

# Examples

- Base 10 – Decimal
- 10 digits { 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 }



## And a NEW ONE!

- Binary
- Important, since circuits can only differentiate between ON and OFF [one (1) and zero (0)]
- Based on only 2 digits { 0, 1 }

## How does it work?

In decimal, the columns go like this

$10^4$	$10^3$	$10^2$	$10^1$	$10^0$
10000	1000	100	10	1

Notice: Base 10 - columns are powers of 10

## So in Binary....

The columns are base 2 !

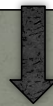
$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
16	8	4	2	1

# Convert from Binary

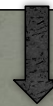
- What is the number  $110_2$  in decimal?

The subscript 2 indicates the base!

32	16	8	4	2	1
			1	1	0



4



2

$$4+2 = 6$$

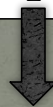
# Convert from Binary

- What is the number  $10101_2$  in decimal?

32	16	8	4	2	1
	1	0	1	0	1



16



4



1

$$16+4+1 = 21$$

# Binary

- Examples

Binary	Decimal
0	0
1	1
10	2
11	3

# Convert TO Binary

- What is the number 71 in binary?

Rules for conversion

- Start with number to convert at the top
- Divide by two:  
listing INTEGER result, and REMAINDER
- Keep dividing the result until you reach zero

Divisor	Value	Remainder
2	71	
2	35	1
	17	1

$71 / 2 = 35$  with 1 remainder

$35 / 2 = 17$  with 1 remainder

# Convert TO Binary

- What is the number 72 in binary?

Divisor	Value	Remainder
2	72	
2	36	0
2	18	0
2	9	0
2	4	1
2	2	0
2	1	0
	0	1



= 1001000<sub>2</sub>

# Convert TO Binary

- What is the number 68 in binary?

Divisor	Value	Remainder
2	68	
2	34	0
2	17	0
2	8	1
2	4	0
2	2	0
2	1	0
	0	1



= 1000100<sub>2</sub>

## Exercises:

1. Convert each of the binary values below to decimal.  
a) 11010    b) 10001    c) 11111    d) 100010
2. Convert each of the decimal values below to binary.  
a) 44    b) 75    c) 135    d) 111
3. Convert each of the binary values below to decimal. Can you find a shortcut?  
a) 101010    b) 1010100    c) 10101000    d) 101010000
4. In defining a colour in html, the component colours are given as a value from 0 to 255 for each of Red/Green/Blue. How many bytes of data does this take per pixel?

## Exercises:

1. Convert each of the binary values below to decimal.  
a) 11010    b) 10001    c) 11111    d) 100010  
Answers:    a) 26    b) 17    c) 31    d) 34
2. Convert each of the decimal values below to binary.  
a) 44    b) 75    c) 135    d) 111  
Answers:    a) 101100    b) 1001011    c) 10000111    d) 110111
3. Convert each of the binary values below to decimal. Can you find a shortcut?  
a) 101010    b) 1010100    c) 10101000    d) 101010000  
Answers:    a) 42    b) 84    c) 168    d) 336
4. In defining a colour in html, the component colours are given as a value from 0 to 255 for each of Red/Green/Blue. How many bytes of data does this take per pixel?