

Numbering Systems

Points to cover:

1. Decimal Numbering System

- Base 10: explain why it is a base 10 system; there are numbers from 0-9
- Explain what are weights and give an example

Value	Weight
1	10^0
10	10^1
100	10^2
1000	10^3
10000	10^4

$$10^2 \quad 10^1 \quad 10^0$$

567

$$5 \times 100 + 6 \times 10 + 7 \times 1 \rightarrow 500 + 60 + 7 \rightarrow 567$$

Section Questions

Please answer these questions with them so they can answer the sheet

1. What is the weight of digit 6 in 1386?

Answer: $10^0 = 1$

2. Express 100 as a power of ten

Answer: $100 = 10^2$

2. Binary Numbering System

- Base 2: Explain why it is a base 2 system; there are numbers from 0 and 1
- Explain the weights in a binary system and give an example

2-Binary Weights

Value	Weight
1	2^0
2	2^1
4	2^2
8	2^3
16	2^4
32	2^5
64	2^6
128	2^7

$2^2 \quad 2^1 \quad 2^0$
101

$$1 \times 4 + 0 \times 2 + 1 \times 1 \rightarrow 4 + 0 + 1 \rightarrow 5$$

Section Questions

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3. What is the highest decimal number that can be represented by 5 numbers of binary digits (bits)?

Answer: 5 bits $\rightarrow$ maximum number all 1s $\rightarrow$ 11111 in binary $\rightarrow$ convert to decimal $\rightarrow$ 31 in decimal(1+2+4+8+16)

3. Binary to Decimal Conversion

- Explain how to convert from binary to decimal using the **sum-of-weights** method
- Give an example

$2^3 \quad 2^2 \quad 2^1 \quad 2^0$

1010

$$1 \times 8 + 0 \times 4 + 1 \times 2 + 0 \times 1 \rightarrow 8 + 0 + 2 + 0 \rightarrow 10$$

4. Decimal to Binary Conversion

- Explain how to convert from decimal to binary using the **sum-of-weights** method
- Give an example

48

i. What's the largest binary number that can be used to represent 48?

$$2^5 \rightarrow 32$$

$2^0=1$	$2^1=2$	$2^2=4$	$2^3=8$	$2^4=16$	$2^5=32$
					1

ii. $48 - 32 = 16$

iii. What's the largest number that can represent 16? $2^4 \rightarrow 16$

$2^0=1$	$2^1=2$	$2^2=4$	$2^3=8$	$2^4=16$	$2^5=32$
				1	1

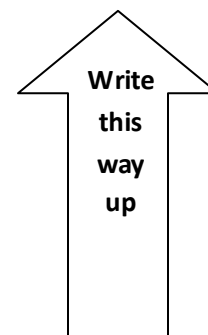
iv. $16 - 16 = 0$

$2^0=1$	$2^1=2$	$2^2=4$	$2^3=8$	$2^4=16$	$2^5=32$
0	0	0	0	1	1

- Explain how to convert from decimal to binary using the **divide-by-2** method
- Give an example

48

Carry (0 = no carry/1=carry)	Divide by 2	Number
0	24	48
0	12	24
0	6	12
0	3	6
1	1.5	3
1	0.5	1



110000

Section Questions

Please answer these questions with them so they can answer the sheet

5. How many bits are required to represent 17?

Answer: Convert 17 to binary → 10001 → count the bits → 5 bits

5. Hexadecimal Numbers:

- Hexa means 16. In the hexadecimal number system, it uses 16 digits. It consists of numbers and alphabets. It includes numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and A, B, C, D, E, F; total 16 digits.
- It is denoted by s_{16} , where s is a hexadecimal number.
- Examples: 1) $A1_{16}$ 2) $EE9_{16}$ 3) $FD654_{16}$

Binary	Hexadecimal
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	B
1100	C
1101	D
1110	E
1111	F

Question 1: Convert $A2B_{16}$ to an equivalent binary number.

Solution: Given hexadecimal number = $A2B_{16}$

First, convert the given hexadecimal to the equivalent decimal number.

$$A2B_{16} = (A \times 16^2) + (2 \times 16^1) + (B \times 16^0)$$

$$= (A \times 256) + (2 \times 16) + (B \times 1)$$

$$= (10 \times 256) + 32 + 11$$

$$= 2560 + 43$$

$$= 2603(\text{Decimal number})$$

Now we have to convert 2603_{10} to binary

The binary number obtained is 101000101011_2

Hence, $A2B_{16} = 101000101011_2$

Question 2: Convert E_{16} to an equivalent binary number.

Solution: Given, a hexadecimal number is E.

First, convert the given hexadecimal to the equivalent decimal number.

$$E_{16} = E \times 16^0$$

$$= E \times 1$$

$$= E$$

$$= 14(\text{Decimal number})$$

Now we have to convert 14_{10} to binary number.

The binary number obtained is 1110_2

Hence, $E_{16} = 1110_2$