

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

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

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

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

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

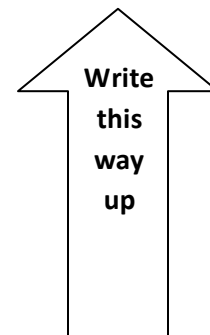
iv. $16 - 16 = 0$

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

Remind students that Calculators are not allowed in the exam

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 s₁₆, where s is a hexadecimal number.
- Examples: 1) A₁₆ 2) EE₁₆ 3) FD654₁₆

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, $E_{16} = 1110_2$