Unit 1. Number Systems, Evolution, Block Diagram and Generations

Number Systems: Binary, Decimal, Octal, Hexadecimal; conversions between number systems. **Evolution of Computers:** History from early mechanical devices to modern-day systems.

Block Diagram of a Computer: Components like Input Unit, Output Unit, Memory, CPU (ALU+CU). **Generations of Computers:** First to Fifth Generation – technologies, characteristics, examples.

Number system in computers:-

A number system is a method of writing and representing numbers using a set of digits.

in daily life, we use the decimal system(0-9), but computers understand only the binary system(0 and 1) because their circuits work with two sates: ON and OFF. these two states are represented by the digits 1 and 0. this is called the binary number system (base 2).

since computers are built with electronic circuits that work with two states (on/off, true/false, yes/no).

--> computers mainly works with the binary system, while humans commonly use the decimal system. for simplicity in programming and digital electronics, octal and hexadecimal systems are also used.

Types of number systems:-

1. Decimal number system
2. Binary number system
3. Octal number system
4. Hexadecimal number system

Number system	Base	Symbols used
Binary	2	0,1
Octal	8	0,1,2,3,4,5,6,7
Decimal	10	0,1,2,3,4,5,6,7,8,9
Hexadecimal	16	0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F

1. Decimal Number system:-

The decimal number system is the most commonly used system in daily life. It is a base-10 system meaning it uses 10 digits.

Ex:- 0,1,2,3,4,5,6,7,8,9

Each digit's position has a place value based on power of 10(ones, tens, hundreds, thousands..)

In computers, input/output is usually shown in decimal, through internally they work in binary.

Ex:- $(526)_{10}$

$(7294)_{10}$

2. Binary number system:-

The binary number system is a base-2 system that uses only two digits 0 and 1. Each digit is called a bit.

Why computers use binary:-

Computers work with electronic circuits that have two states:

- ON (represented by 1)
- OFF (represented by 0)

So, all computer data (numbers, text, images, sounds) is stored and processed in binary form.

Ex:- (100101)2

(111011)2

Bit :-

A bit (short for binary digit) is the smallest unit of data in a computer.

It can have only two possible values.

0 – represent OFF/ False

1 – represents ON/ true

1 bit= one binary value (0 or 1).

Bit is classified into 2 types:-

1. Nibble 2. Byte

1. Nibble:-

A nibble is a group of 4 bits.

Ex:-

1	0	1	0

2. Byte:-

A byte is a group of 8 bits. (or 2 Nibbles).

Ex:-

1	0	0	1	1	1	0	0

3. Octal number system:-

Octal numbers are the numbers which have base 8. It is represented as N8. It uses the digits 0,1,2,3,4,5,6,7 to represent the numbers in this number system.

Ex:- (112)8

(727)8

4. Hexadecimal number system:-

The base of a hexadecimal system is 16. The 16 symbols involved in this system include 10 decimal digits and the first six letters of the English alphabet.

Ex:- 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F.

Here, the alphabets can be treated 10,11,12,13,14,15.

Conversions between Number Systems

Conversion is the process of changing a value from one form into another.

In computers conversion usually refers to changing a number from one number system to another.

Ex:-

Decimal to Binary conversion

Binary to decimal conversion

Octal to decimal conversion.

Place values in Decimal Number system:-

Each position in a decimal number represents a **power of 10**:

- Rightmost digit → 10^0=1 (ones place)
- Next digit → 10^1=10 (tens place)
- Next digit → 10^2=100 (hundreds place)
- Next digit → 10^3=1000 (thousands place), and so on.

Ex:- convert 452(Decimal number) into Expanded form(place value form)

$(452)_{10}$= ($4x10^2$) + ($5x10^1$)+($2x10^0$)

=(4x100) + (5x10) + (2x1)

=400+50+2

=452

Decimal to Binary Conversion:-

Binary numbers use base-2 number system. To convert a decimal number to binary, follow the steps given below.

Step 1: Divide the decimal number by 2.

Step 2:- Write its remainder.

Step 3: Keep on dividing the quotient by the base value 2 and note the remainder till the quotient is zero.

Step 4: Collect the remainders from bottom to top to get the binary equivalent.

Ex:- convert $(243)_{10}$ to Binary number.

2	243	
2	121	→ 1
2	60	→ 1
2	30	→ 0
2	15	→ 0
2	7	→ 1
2	3	→ 1
2	1	→ 1

==> So $(243)_{10}$= $(11110011)_2$.

Ex:- convert 45(decimal) to Binary ?

45/2 = 22 → 1 (remainder)

22/2= 11 → 0

11/2= 5 → 1

5/2= 2 → 1

2/2= 1 → 0

1/2 = 0 → 1

So (45)10= (101101)2

Ex:- find the binary equivalent of decimal number 25.

2	**25**	
2	**12**	**→ 1**
2	**6**	**→ 0**
2	**3**	**→ 0**
2	**1**	**→ 1**
	0	**→ 1**

(25)10= (11001)2

<u>Decimal Number with Fractional Part to another Number System:-</u>

Ex:- convert (0.25)10 to binary.

	Integer part	fractional part
0.25 x 2 = 0.50	0	0.50
0.50 x 2 = 1.00	1	0.00

Since the fractional part is 0, the multiplication is stopped. Write the integer part from top to bottom to get binary number for the fractional part. Therefore, (0.25)10 = (0.01)2

Ex:- convert (0.675)10 to binary ?

	Integer part	fractional part
0.675 x 2= 1.350	1	0.350
0.350 x 2=0.700	0	0.700
0.700 x 2=1.400	1	0.400
0.400 x 2=0.800	0	0.800
0.800 x 2=1.600	1	0.600
0.600 x 2=1.200	1	0.200
0.200 x 2=0.400	0	0.00

Since the fractional part (.400) is the repeating value in the calculation, the multiplication is stopped. Write the integer part from top to bottom to get binary number for the fractional part. Therefore, (0.675)10= (0.1010110)2

Ex:- convert (0.675)10 to octal ?

	Integer part	fractional part
0.675 x 8=5.400	5	0.400
0.400 x 8=3.200	3	0.200
0.200 x 8=1.600	1	0.600
0.600 x 8=4.800	4	0.800
0.800 x 8=6.400	6	0.400

Since the fractional part (.400) is repeating, the multiplication is stopped. Write the integer part from top to bottom to get octal number for the fractional part. Therefore, (0.675)10 = (0.53146)8

Ex:- convert (0.675)10 to hexadecimal form ?

	Integer part	floating part
0.675 x 16 = 10.800	10 (A)	0.800
0.800 x 16=12.800	12(C)	0.800

Since the fractional part (.800) is repeating, the multiplication is stopped. Write the integer part from top to bottom to get hexadecimal equivalent for the fractional part. Therefore, (0.675)10 =(0. AC)16

Ex:- convert the following decimal numbers(fractions) into binary.

i) 38.15 ii) 18.75 iii) 24.7 iv) 42.5

Answer:-

i) 38.15

integer value=38

floating or decimal value=0.15

38/2=19 →0

19/2=9 →1

9/2=4 →1

4/2=2 →0

2/2=1 →0

1/2=0 →1

So 38 binary value is 100110

	Integer	decimal
0.15 x 2= 0.30	0	0.30
0.30 x 2= 0.60	0	0.60
0.60 x 2=1.20	1	0.20
0.20 x 2=0.40	0	0.40
0.40 x 2=0.80	0	0.80
0.80 x 2=1.60	1	0.60

So fractional value is 0011001 n

Note:- (if the fractional decimal keeps repeating during binary conversion, it means the fraction cannot be represented exactly in binary. In such cases, we stop after the required number of digits(for example, stop after 5 digits) and write it as an approximation.)

Binary equivalent of decimal is (38.15)10=(001001)2

ii) 18.75

18/2=9 → 0

9/2=4 → 1

4/2=2 → 0

2/2=1 → 0

1/2 =0 → 1

18=10010

	Integer	Decimal
0.75 x 2= 1.50	1	0.50
0.50 x 2= 1.00	1	0.00

0.75=11

The binary equivalent of decimal 18.75 is 10010.11

iii) 24.7

integer=24

floating or fractional point=0.24

24 / 2 =12 → 0

12/2=6 → 0

6/2=3 → 0

3/2=1 → 1

1/2=0 → 1

24=11000

	Integer	Decimal
0.7 x 2=1.4	1	0.4
0.4 x 2 = 0.8	0	0.8
0.8 x 2= 1.6	1	0.6
0.6 x 2=1.2	1	0.2
0.2 x 2=0.4	0	0.0

0.7=10110 ==> The binary euivalent of decimal 24.7 is 11000.10110

iv) 42.5

integer=42

floating= 0.5

42/2=21 →0

21/2=10 →1

10/2=5 →0

5/2=2 →1

2/2=1 →0

1/2=0 →1

42=101010

	Integer	Decimal
0.5 x 2= 1.0	1	0.0

The binary equivalent of decimal 42.5 is 101010.1

Ex:- convert (13)10 to an equivalent base-2 number.

13/2=6 → 1

6/2 =3 → 0

3/2 = 1 →1

1/2 =0 →1

(13)10=(1101)2

<u>Non-decimal Number with Fractional Part to Decimal Number System:-</u>

Compute positional value of each digit in the given number using its base value. Add the product of positional value and the digit to get the equivalent decimal number with fractional part.

Ex:- convert (100101.101)2 into decimal ?

1 0 0 1 0 1 . 1 0 1

2^5 2^4 2^3 2^2 2^1 2^0 2^{-1} 2^{-2} 2^{-3}

=32+0+0+4+0+1 +0.5+ 0+ 0.125

=37 + 0.625

Therefore, (100101.101)2= (37.625)10

Ex:- convert (605.12)8 into decimal number ?

6 0 5 . 1 2

8^2 8^1 8^0 8^{-1} 8^{-2}

=384+0+5 + 0.125+0.3125

=389 + 0.15625

Therefore , (605.12)8= (389.15625)10

Binary to Decimal Conversion:-

If a binary number has to be converted into decimal number, then we should multiply, the positional values of each bit with the bit value and add. As an example, the decimal equivalent of 11011 is calculates as follows.

(11011)2= $(1x2^4)$ + $(1x2^3)$ +$(0x2^2)$ +$(1x2^1)$+$(1x2^0)$

= 16 + 8 + 0 + 2 + 1

= 27

The decimal equivalent of the binary number 11011 is 27.

Converting binary to decimal:-

(multiply each binary digit by 2 raised to its position power – from right to left, starting at 0).

Step 1:- write positions or place values (power of 2)

(1011)2= (1×2^3) +(0×2^2) + (1×2^1) + (1×2^0)

Step 2:- solve powers of 2.

2^3= 8

2^2= 4

2^1= 2

2^0 = 1

Step 3:- multiply and add.

=(1 x 8) + (0 x 4) + (1 x 2) + (1 x 1)

=8+0+2+1

=11

The decimal equivalent of the binary number 1011 is 11.

<u>Decimal to Octal Conversion:-</u>

Step 1: Divide the decimal number by 8

Step 2: Write its remainder

Step 3: Keep on dividing the quotient by the base value 8 and note the remainder till the quotient is zero.

Step 4:- Collect the remainder from bottom to top to get the octal equivalent.

Ex:- convert (127)10 to octal number system.

8	127	
8	15	→ 7
8	1	→ 7
8	0	→ 1

(127)10= (177)8

Ex:- convert (52)10 to octal

8	52	
8	6	→ 4
8	0	→ 6

==> (52)10= (64)8

To convert a number given in the decimal number system in to octal system, one should divide for integers and multiply for fractions successively by 8. Hence the octal equivalent of the decimal number 18.6875 is calculated as follows.

8	18	
8	2 → 2	
	0 → 2	=> 22

	Integer	Decimal	
0.6875 x 8 =5.5000	5	0.5000	
0.5000 x 8= 4.0000	4	0.000	→0.54

Therefore the octal equivalent of the decimal number 18.6875 is 22.54

Ex:- convert (974.35)10 in to octal.

8	974	
8	121 → 6	
8	15 → 1	
8	1 → 7	
	0 → 1	→ 1716

	Integer	decimal	
0.35 x 8 = 2.80	2	0.80	
0.80 x 8 = 6.40	6	0.40	
0.40 x 8 = 3.20	3	0.20	
0.20 x 8 = 1.60	1	0.60	
0.60 x 8 =4.80	4	0.80	→ 0.26314

The octal equivalent of (974.35)10 is (1716.26314)8

Octal to Decimal Conversion:-

To convert an octal number to a decimal number we need to multiply each digit of the given octal with the reducing power of 8.

Ex:- convert (215)8 to Decimal Number System.

$(215)_8 = (2 \times 8^2) + (1 \times 8^1) + (5 \times 8^0)$

$= 128 + 8 + 5$

$= (141)_{10}$

$(215)_8 = (141)_{10}$

Ex:- let 125 is an octal number denoted by (125)8. Find the decimal number.

$(125)_8 = (1 \times 8^2) + (2 \times 8^1) + (5 \times 8^0)$

$= 64 + 16 + 5$

$= 85$

$(125)_8 = (85)_{10}$

The octal number can be converted into the equivalent decimal number in the same manner as the binary to decimal conversion. The only difference is that we consider the power of 8 instead of 2. Therefore the decimal equivalent of the octal number 22.74 is calculated as

$(22.74)_8 = (2 \times 8^1) + (2 \times 8^0) + (7 \times 8^{-1}) + (4 \times 8^{-2})$

$= (2 \times 8) + (2 \times 1) + (7 \times 0.125) + (4 \times 0.015625)$

$= 16+2+0.875+0.0625$

$= 18.9375$

The decimal equivalent of octal number $(22.74)_8$ is $(18.9375)_{10}$.

Ex:- convert (306.2)8 in to Decimal

$(306.2)_8 = (3 \times 8^2) + (0 \times 8^1) + (6 \times 8^0) + (2 \times 8^{-1})$

$= (3 \times 64) + 0 + (6 \times 1) + (2 \times 0.125)$

$= 192+6+0.25$

$= 198.25$

The decimal equivalent of $(306.2)_8$ is $(198.25)_{10}$

Octal to binary conversion:-

Method -1

Conversion of octal to binary number is a two-step process.

1). Convert given octal number to decimal number

2). Convert decimal into binary.

Ex:- convert (41)8 to a binary number.

$(41)8 = (4 \times 8^1) + (1 \times 8^0)$

$= 32+1$

$= 33$

2	33	
2	16	→ 1
2	8	→ 0
2	4	→ 0
2	2	→ 0
2	1	→ 0
	0	→1

(412)8 = (100001)2

Method-2:-

Converting an octal number to binary(using the 3-bit table.

0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

8 / 2 = 4 (4 zeros and 4 ones)

4 / 2 = 2 (2 zeros and 2 ones)

2 / 2 = 1 (1 zeros and 1 ones)

-> every octal digit (0-7) equals exactly 3 binary bits (000 to 111).

-> octal number system has base 8 (digits 0-7)

-> binary number system has base 2 (digits 0-1)

->since octal base is 8 and binary base is 2, we divide 8 by 2 repeatedly to prepare the table. First we write 4 zeros and 4 ones, then 2 zeros and 2 ones repeated, and finally 0 and 1 alternately. This gives the 3-bit binary codes for digits 0-7. Hence , every octal digit is represented using exactly 3 binary digits.

Ex:- convert (243)8 to binary

2=010

4=100

3=011

(243)8 = (010100011)2

Ex:- convert (23.54)8 to binary ?

2=010

3=011

5=101

4=100

(23.54)8= (010011.101100)2

Ex:- (765.301)8 in to binary ?

7=111

6=110

5=101

3=011

0=000

1=001 ==>(765.301)8= (111110101.011000001)2

Binary to octal conversion:- (you have to solve problem using the above table).

While converting binary to octal, if the integer part does not form complete 3 bits, add zeros on the left. For the fractional or floating point , if it does not form complete 3 bits, add zeros on the right.

Ex:- convert (10010.1011)2 to octal ?

010=2

010=2

101=5

100=4

(10010.1011)2= (22.54)8

Ex:- convert (1011010.10111)2 into octal ?

001=1

011=3

010=2

101=5

110=6

(1011010.10111)2= (132.56)8

Hexadecimal to Decimal conversion:-

To convert a hexadecimal number to decimal(base-10), multiply each digit by its corresponding power of 16 and sum the results.

Step 1:- write the decimal values of the symbols used in the hexadecimal number from A-F.

Step 2:- multiply each digit of the hexadecimal number with its place value. Starting from right to left.

Step 3:- add the result of multiplication and the final sum will be the decimal number.

Ex:- to convert (8EB4)16 into a decimal value.

(8EB4)16=(8 x 16^3) + (14 x 16^2) + (11 x 16^1) + (4 x 16^0)

=32768+3584+176+4

=36532

(8EB4)16= (36532)10

<u>Decimal to Hexadecimal Conversion:-</u>

Step 1: Divide the decimal number by 16

Step 2: Write its remainder

Step 3: Keep on dividing the quotient by the base value 16 and note the remainder till the quotient is zero

Step 4: Collect the remainders from bottom to top to get the hexadecimal equivalent.

Ex:- convert (47)10 to hexadecimal ?

16	47	
16	2	→ 15 (F)
	0	→ 2

==> (47)10= (2F).

Ex:- convert (2653)10 to hexadecimal ?

16	2653	
16	165	→ 13 (D)
16	10	→ 5
16	0	→ 10 (A)

(2653)10 = (A5D)16

To convert a decimal number in to hexadecimal number system, one should divide multiply successively by 16. Hence the hexadecimal equivalent of the decimal number 28.6875 is calculated as follows:

28.6875

28 is integer part and 0.6875 is a fractional part.

16	28	
16	1	→ 12 (C)
	0	→ 1 ==> 1C

	Integer	Decimal
0.6875 x 16 = 11.0	11 (B)	0.00

Therefore the hexadecimal equivalent of decimal number 28.6875 is 1C. B (since hexadecimal equivalent of 12 is C and 11 is B)

Ex:- convert (873.75)10 in to Hexadecimal ?

16	873	
16	54	→ 9
16	3	→ 6
16	0	→ 3 ==> 369

0.75 x 16 = 12.00 (C)

The hexadecimal equivalent of (873.75)10 is 369.C

<u>Hexadecimal to Binary conversion:-</u>

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

16 / 2= 8 (8 zeros and 8 ones)

8 / 2= 4 (4 zeros and 4 ones)

4 / 2= 2 (2 zeros and 2 ones)

2 / 2=1 (1 zeros and 1 ones)

Ex:- convert (B2E)16 to binary ?

B(11)=1011

2=0010

E(14)=1110

(B2E)16= (101100101110)2

Ex:- convert (7C5)16 to Binary ?

7=0111

C(12)= 1100

5= 0101

(7C5)16= (011111000101)2

<u>Binary to Hexadecimal Conversion:-</u>

Ex:- convert (101101)2 to Hexadecimal

Step 1: group into 4-bits (right to left)

101101=0010 1101

0010= 2

1101 = D (13)

Final answer is (101101)2= (2 D)16.

Ex:- (111100101)2 to Hexadecimal number ?

111100101= 0001 1110 0101

0001= 1

1110= E (14)

0101= 5

(11110010101)2=(1E5)16

Hexadecimal to Octal conversion:-

Steps to convert hexadecimal to octal:-

1. write the hexadecimal number
2. convert each hexa digit to 4-bit binary.
3. group the binary digits in 2 bits from right to left.
4. convert each 3-bit group into octal.

Ex:- convert (1A3)16 to octal ?

1=0001

10(A)= 1010

3= 0011

(1A3)16= (000110100011)2

Converting binary to octal form

000 =0

110 = 6

100= 4

011= 3

(1A3)16= (643)8

Ex:- convert (2F)16 to octal ?

Step 1: hexa to binary

2=0010

F(15)=1111

So (2F)16= (00101111)2

Step 2: group binary in 3-bits

000=0

101=5

111=7

So (2F)16= (57)8

Octal to Hexadecimal Conversion:-

Step 1:- convert octal to decimal we expand the octal number using power of 8.

Step 2:- convert Decimal to Hexadecimal now divide the decimal number repeatedly by 16.

Ex:- conversion of (3500)8 into Hexadecimal ?

$(3500)_8 = (3 \times 8^3) + (5 \times 8^2) + (0 \times 8^1) + (0 \times 8^0)$

$= 1536 + 320 + 0 + 0$

$= (1856)_{10}$

16	1856
16	116 → 0
16	7 → 4
16	0 → 7

Now write the remainders from bottom to top.

$(1856)_{10} = (740)_{16}$

Ex:- convert 745 octal number to Hexadecimal number ?

$(745)_8 = (7 \times 8^2) + (4 \times 8^1) + (5 \times 8^0)$

$= 448 + 32 + 5$

$= 485.$

16	485
16	30 → 5
16	1 → 14 (E)
16	0 → 1

Now write the remainders from bottom to top.

$(485)_{10} = (1E5)_{16}$

Final answer is $(745)_8 = (1E5)_{16}$.

Ex:- (465)8 to hexadecimal conversion ?

$(465)_8 = (4 \times 8^2) + (6 \times 8^1) + (5 \times 8^0)$

= 256 + 48 + 5

= 309

16	309	
16	19	→ 5
16	1	→ 3
	0	→ 1

(465)8= (135)16.

FEATURE	DECIMAL	BINARY	OCTAL	HEXADECIMAL
Digits used	0-9	0,1	0-7	0-9,A-F
Base	Base 10	Base 2	Base 8	Base 16.
Position values	Powers of $(10^0, 10^1, 10^2)$	Power of $2(2^0, 2^1, 2^2)$	Power of $8(8^0, 8^1, 8^2)$	Power of 16 $(16^0, 16^1, 16^2)$
Common use	Everyday life, general calculations.	Computers understandable language	Shorthand for binary(3 bits per digit)	Compact binary representation(4 bits per digit) & used in CSS for color codes
Example	(15)10	(1011)2	(43)8	(3EA)16

Representation of Characters :-

1. **ASCII:-**

(AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE).

Is a character encoding system in computer(means converting human-readable characters into computer-readable numbers(binary)) uses 7 bits to represent each character in computer memory.

→ the main purpose of ASCII is to provide a standard way of representing characters(letters, numbers, symbols and controlkeys) in computers using numeric codes.

Total values in ASCII:-

1). Standard ASCII- 0-127 values

2). Extended ASCII – 0-255 values.

A-Z(uppercase) = 65 to 90

a-z (lowercase) = 97-122

digits(0-9) = 48-57

space= 32

Enter(new line) =10

Tab =9

2. EBCDIC :-

It stands for Extended Binary Coded Decimal Interchange Code. This is similar to ASCII and is an 8 bit code used in computers manufactured by international Business Machine (IBM). It is capable of encoding 256 characters.

3. ISCII :-

ISCII stands for Indian Standard Code for Information Interchange or Indian Script Code for Information Interchange. It is an encoding scheme for representing various writing systems of India. ISCII uses 8-bits for data representation. It was evolved by a standardisation committee under the Department of Electronics during 1986-88, and adopted by the Bureau of Indian Standards (BIS). Nowadays ISCII has been replaced by Unicode.

4. Unicode :-

Using 8-bit ASCII we can represent only 256 characters. This cannot represent all characters of written languages of the world and other symbols. Unicode is developed to resolve this problem. It provides a unique number for every character, no matter what the language and platform be.

Unicode can represent characters in almost all written language of the world.

Introduction to Computers:-

Father of computer :-

Charles Babbage is considered to be the father of computer, father of computer, for his invention and the concept of ***Analytical Engine*** in 1837. The Analytical Engine contained an Arithmetic Logic Unit (ALU), basic flow control, and integrated memory; which led to the development of first general purpose computer concept.

Computer : The word Computer is derived from a Latin word "computare or compute" which means to "to calculate", "to count", "to sum up" or "to think together". An electronic device which accepts input from the user, processes it according to the instructions given to it and gives the required result in the form of output, is a computer.

Computer System:-

A computer can process data, images, audio, video and graphics. A computer performs five major computer operations or functions irrespective of their size and make. These are-

1) It accepts data or instructions by way of input.

2) It stores data.

3) It can process data as required by the user.

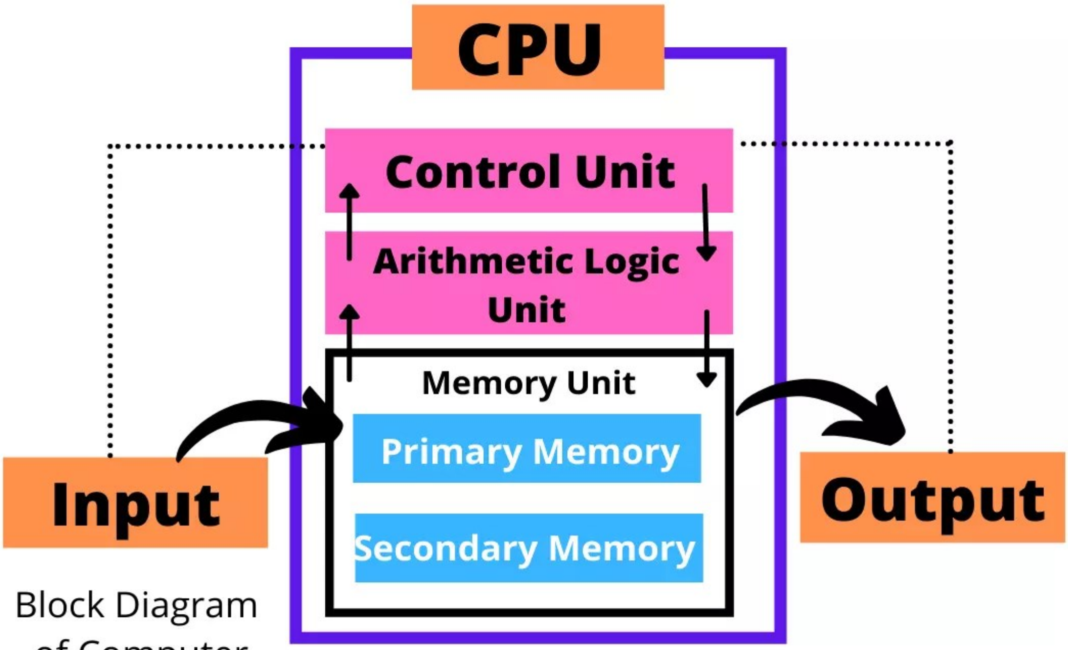
4) It gives results in the form of output.

5) It controls all operations inside a computer.

Block Diagram of Computer:-

Computer :-

A computer is an electronic device that can be programmed to accept data (input), process it and generate result (output). A computer along with additional hardware and software together is called a computer system.



Block Diagram of Computer

<u>Input Devices:-</u>

An input device is a hardware component used to provide data and control signals to a computer system.

The devices through which control signals are sent to a computer are termed as input devices. These devices convert the input data into a digital form that is acceptable by the computer system.

Ex:-1). Keyboard (used for typing letters, numbers, symbols)

2). Mouse (used to point, select and move objects on screen).

3). Scanner (converts physical documents into digital form)

4). Touch Screen.

Data entered through input device is temporarily stored in the main memory (also called RAM) of the computer system. For permanent storage and future use, the data as well as instructions are stored permanently in additional storage locations called secondary memory.

Output Devices:-

An output device is a hardware component that receives data from the computer system for display, physical production etc.. is called output device. It converts digital information into human understandable form.

Ex:-

1). Monitor (displays text, images, videos)

2). Projector (projects images and video onto a large screen)

3). Printer (produce hard copies – paper output)

4). Speakers (output sound music, notification).

(a printer is most commonly used device to get output in physical(hardcopy) form. Three types of commonly used printers are inkjet, laserjet and dot matrix. Now a days, there is a new type of printer called 3-D printer, which is used to build physical replica of a digital 3D design).

Central Processing Unit (CPU) :-

The CPU is often called the "***Brain of the Computer System***" because it is responsible for executing instructions and processing data to make the computer function.

It is commonly called processor also. Physically, a CPU can be placed on one or more microchips called integrated circuits (IC). The ICs comprise semiconductor materials.

While processing, the CPU stores the data as well as instructions in its local memory called registers. Registers are part of the CPU chip and they are limited in size and number.

Different registers are used for storing data, instructions or intermediate results.

Main Components of CPU:-

1). Arithmetic Logic Unit (ALU)

→ performs mathematical operations (addition, subtraction, multiplication, division).

→ performs logical operations (comparisons like greater than, equal to , less than).

2). Control Unit:-

→ directs the flow of data between CPU, memory and input/output devices.

→ it is control the system.

3). Memory unit :-

Memory is an internal storage area in the computer, which is used to store data and programs temporarily or permanently.

Computers have two types of memory- primary and secondary.

(A). Primary Memory:-

Primary memory is an essential component of a computer system. Program and data are loaded into the primary memory before processing. The CPU interacts directly with the primary memory to perform read or write operation.

It is of two types – RAM and ROM.

RAM:-

RAM is volatile, as long as the power is supplied to the computer, it retains the data in it. But as soon as the power supply is turned off, all the contents of RAM are wiped out.

It is used to store data temporarily while the computer is working. RAM is usually referred to as main memory and it is faster than the secondary memory or storage device.

RAM is the most important memory. The data after having been fed by keyboard or other input devices and before process, get stored in RAM and it is retrieved from there via CPU. Data or programs are stored temporarily in RAM. The data get erased when the computer is switched off or when electricity fails. That is why RAM is called temporary or volatile memory.

ROM:-

ROM is non-volatile, which means its contents are not lost even when the power is turned off.

It is used as a small but faster permanent storage for the contents which are rarely changed.

Programs stored in this memory cannot be changed or destroyed and they can be only read. This memory is called permanent or non-volatile. This memory is used to store basic instructions. The best example of ROM is BIOS (basic input output system) in which the booting program is stored.

When computer is turned on it gets information from ROM and starts booting. ROM is used in automatic machines, toys etc.

ROM is three types:-

1. PROM(Programmable ROM)
2. EPROM(Erasable Programmable ROM)
3. EEPROM(Electrically Erasable Programmable ROM)

(B). Secondary Memory:-

The secondary memory is non-volatile and has larger storage capacity than primary memory. It is slower and cheaper than the main memory. It is also called auxiliary memory.

Ex:- HDD (Hard Disk Drive), CD/DVD, memory card, SSD.

(C) Cache Memory:-

RAM is faster than secondary storage, but not as fast as a computer processor. So, because of RAM, a CPU may have to slow down. To speed up the operations of the CPU, a very high speed memory is placed between the CPU and the primary memory known as cache.

It stores the copies of the data from frequently accessed primary memory locations. When the CPU needs some data, it first examines the cache. In case the requirement is met, it is read from the cache, otherwise the primary memory is accessed.

Units of Memory:-

In memory information is stored in the form of bits. Bit is a word which has been formed with binary digit. There are only two digits 0 and 1 in this system. The value of a bit may be 0 or 1.

In the electronic circuit of a computer "1" means pulse is present and "0" means pulse is absent.

In a computer all the data is stored in either 0 or 1. But it is very difficult for man to provide all the information using 0 or 1 so the user gives all the inputs to computer in his own language and the computer changes them into its own language(bit). When a key "A" is pressed in the memory of the computer 1000001 is fed.

Through bit is the primary unit of memory yet it is so small that it is not used for measuring memory. Generally for measuring memory byte unit is used. Eight bits make a byte.

The different units of memory can be presented in the following manner.

1. **Bit:-** the smallest unit of memory. In binary number system its value is either 0 or 1.

2.**Nibble**: the set of 4 bits is called nibble.

So 1 nibble = 4 bits

3**. Byte**: the set of 8 bits is known as a byte. Generally a character is represented through one byte.

So 1 byte= 8 bits

4. kilobyte(KB):- 1024 bytes make 1 KB

5. Megabyte(MB):- 1024 KB from 1 MB

6. Gigabyte (GB):- 1024 MB from 1 GB

7. Terabytes(TB):- 1024 GB together are known as 1 terabyte.

<u>Evolution of computer:-</u>

From the simple calculator to a modern day powerful data processor, computing devices have evolved in a relatively short span of time.

1). 500 BC (Abacus):-

Computing is attributed to the invention of ABACUS almost 3000 years ago. It was a mechanical device capable of doing simple arithmetic calculations only.

The word "abacus" means calculating board. An abacus consisted of beads on movable rods divided into two parts. The abacus may be considered the first computer for basic arithmetical calculations.

The abacus is also called a counting frame, a calculating tool for performing arithmetic operation. The abacus works on the basic of the place value system.

2). 1642 (Pascaline):-

Blaize Pascal invented a mechanical calculator known as Pascal calculator or Pascaline to do addition and subtraction of two numbers directly and multiplication and division through repeated addition and subtraction.

3). 1834 (Analytic Engine):-

Charles Babbage invented analytical engine, a mechanical computing device for inputting, processing, storing and displaying the output, which is considered to form the basis of modern computers.

4). 1890 (Tabulating Machine):-

Herman Hollerith designed a tabulating machine for summarising the data stored on the punched card. It is considered to be the first 1945 step towards programming.

5). 1937 (Turing Machine):-

The Turing machine concept was a general purpose programmable machine that was capable of solving any problem by executing the program stored on the punched cards.

6). 1945 (EDVAC/ENIAC):-

John Von Neumann introduced the concept of stored program computer which was capable of storing data as well as program in the memory. The EDVAC and then the ENIAC computers were developed based on this concept.

7). 1947 (Transistor):-

Vacuum tubes were replaced by transistors developed at Bell Labs, using semiconductor materials.

8). 1970 (Integrated Circuit):-

An Integrated Circuit (IC) is a silicon chip which contains entire electronic circuit on a very small area. The size of computer drastically reduced because of ICs.

Generation of Computers:-

Growth in the computer industry is determined by the development in technology.

Based on various stages of development, computers can be categorised into different generations.

SN	Generation	Period	Main Component Used	Merits / Demerits / Features
1	**First Generation**	1940 – 1956	Vacuum Tubes	- Big in size - Consumed more power - Malfunction due to overheating - Machine language was used
2	**Second Generation**	1956 – 1964	Transistors	- Smaller compared to first generation - Consumed less power - Faster and more reliable - Assembly language was used
3	**Third Generation**	1964 – 1971	Integrated Circuits (IC)	- High performance - More reliable - Supported high-level languages - Reduced size and cost
4	**Fourth Generation**	1971 – 1980	Microprocessor (VLSI – Very Large Scale Integration)	- Smaller, faster, cheaper - Portable computers introduced - Use of personal computers increased
5	**Fifth Generation**	1980 – till date	Ultra Large Scale Integration (ULSI), Artificial Intelligence	- Use of AI - Parallel processing - High speed and accuracy - Computers became smaller and powerful
6	**Sixth Generation**	In Future	Parallel & Distributed Computing, AI, Robotics, NLP	- Smarter, faster, smaller computers - Development of robotics - Natural Language Processing (NLP) - Voice recognition software

First Generation (1942-1956):-

During this generation, vaccum tubes were used in computers. Vaccum tubes were large in size, so the size of the computer of this generation was big. They were slow in speed, punch cards were used for input and output. Magnetic drums were used for internal memory. Machine and Assembly languages were used. The main computers of this generation were: ENIAC, EDVAC.

Second Generation (1955-1964):-

The second generation computers were based on transistors. Transistor was invented by Bell Laboratories in 1947. Transistors is a solid state device made of semi conductor metal. They served the same "function" as was done by the vaccum tubes in the computers of the first generation.

But they were much smaller in size compared to the vaccum tubes and they were comparatively more reliable and faster in working speed. They also consumed very less power.

The main computers of this generation were : IBM-70 series, IBM1400 series.

Third Generation (1964-1975):-

In this generation the transistors in computers were replaced with integrated circuit(IC). The **third generation of computers** used integrated circuits (ICs), where smaller transistors were placed on silicon chips, greatly improving speed and efficiency.

The main computers of the generation were: IBM-360, ICL-1900, VAX-750 etc..

Fourth Generation (1975-1989):-

In the computers of this generation Very Large Scale Integrated Circuits (VLSI) were used. In one fourth of an inch of these circuits lakhs of transistors and other electronic components are used. Hence, the circuits were called Microchips.

The first microchip intel4004 was prepared by Intel Corporation in 1970. This small chip later began to be called micro processor. The computer with microprocessor is called micro computers.

Fifth Generation (1989 to till date):-

These computers are still in the process of evolution. It is being tried to develop in them the intellectual capacities like the power of reasoning, thinking, understanding and taking decision etc.

These computers are going to be faster at speed, more reliable and can work in unfavorable conditions.

Microprocessors:-

A processor(CPU) which is implemented on a single microchip is called microprocessor. Nowadays , almost all the CPUs are microprocessors.

Microprocessor is a small-sized electronic component inside a computer that carries out various tasks involved in data processing as well as arithmetic and logical operations.

The first processor Intel 4004 was developed in 1971 by Intel corporation and consisted of 2300 transistors integrated into a single IC.. some popular microprocessors and the number of transistors integrated in them are given below.

Processor	Transistor Count
Intel 8086	29,000
Motorola 68000(used in apple)	68,000
Intel Pentium	31,00,000
AMD K7	2,20,00,000
Core i7	73,10,00,000

Important Questions:-

5 Marks :-

1). What is the need of RAM? How does it differ from ROM?

2). Name the input or output device used to do the following:

a) To output audio

b) To enter textual data

c) To make hard copy of a text file

d) To display the data or information

e) To enter audio-based command

f) To build 3D models

g) To assist a visually-impaired individual in entering data

3). Convert (23D)16 to binary number.

4). Try the following conversions.

(i) (514)8 = (?)10

(ii) (220)8 = (?)2 = (?)10

(iii) (76F)16 = (?)10

(iv) (4D9)16

(v) (11001010)2 = (?)10

5). Do the following conversions from decimal number to other number systems.

(i) (54)10 = (?)2

(ii) (120)10 = (?)2

(iii) (76)10 = (?)8

(iv) (889)10 = (?)8

(v) (789)10 = (?)16

(vi) (108)10 = (?)16

6). Express the following decimal numbers into hexadecimal numbers.

(i) 548 (ii) 4052 (iii) 58 (iv) 100.25

7). Express the following hexadecimal numbers into equivalent decimal numbers.

(i) 4A2 (ii) 9E1A (iii) 6BD (iv) 6C.34

6). Express the following octal numbers into their equivalent decimal numbers.

(i) 145 (ii) 6760 Ch 2.indd 43 (iii) 455 (iv) 10.75

7). Write a note on ASCII code.

8). Divide the following list of devices into appropriate categories (input and output devices).

(Monitor, Barcode reader, Printer, Keyboard, Optical character reader, Speaker)

9). What are the components of a CPU?

10). Define number system. Write short notes on Binary and Decimal systems.

10 Marks:-

1). Explain generations of computers in details.

2). Draw the block diagram of a computer system. Detailly write about the functionality of each component.

3). Explain different types of number systems (Binary, Decimal, Octal, Hexadecimal) with suitable examples.

4). Describe the evolution of computers from early mechanical devices to modern digital systems.