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Unit ⇒ 1

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Number System and codes

★ Number System :- Binary, Octal, Decimal and Hexadecimal

✳ Decimal to Binary

(1.)

$$\begin{array}{r|ll} 2 & 14 & 0 \\ 2 & 7 & 1 \\ 2 & 3 & 1 \\ & 1 & \end{array}$$ Decimal

$(1110)_2$ Binary

1	1	1	0
2^3	2^2	2^1	2^0

$8\times1 + 4\times1 + 2\times1 + 1\times0$

$8 + 4 + 2$

14 Ans

(2)

$$\begin{array}{r|ll} 2 & 53 & 1 \\ 2 & 26 & 0 \\ 2 & 13 & 1 \\ 2 & 6 & 0 \\ 2 & 3 & 1 \\ & 1 & \end{array}$$

1	1	0	1	0	1
2^5	2^4	2^3	2^2	2^1	2^0

$32\times1 + 16\times1 + 8\times0 + 4\times1 + 2\times0 + 1\times1$

$32 + 16 + 0 + 4 + 0 + 1$

53 Ans

$(110101)_2$

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1. Decimal number 14 into Binary number.

$$\begin{array}{r|l l} 2 & 14 & 0 \\ 2 & 7 & 1 \\ 2 & 3 & 1 \\ & 1 & \end{array}$$

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Binary number :- $(1110)_2$

★ Binary number $(1110)_2$ into Decimal number.

1	1	1	0
↓	↓	↓	↓
2^3	2^2	2^1	2^0
↓	↓	↓	↓
8×1	4×1	2×1	1×0
↓	↓	↓	↓
8	4	2	0

$8 + 4 + 2 =$ Decimal no $= 14$

2. Decimal number 53 into Binary number.

$$\begin{array}{r|l l} 2 & 53 & 1 \\ 2 & 26 & 0 \\ 2 & 13 & 1 \\ 2 & 6 & 0 \\ 2 & 3 & 1 \\ & 1 & \end{array}$$

Binary number → $(110101)_2$

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★ Binary number $(110101)_2$ into Decimal number.

Binary number → 1 1 0 1 0 1

$2^5 \quad 2^4 \quad 2^3 \quad 2^2 \quad 2^1 \quad 2^0$

$32 \times 1 + 16 \times 1 + 8 \times 0 + 4 \times 1 + 2 \times 0 + 1 \times 1$

$32 + 16 + 8 + 4 + 2 + 1$

53 Ans

3. Decimal number 247 into Binary number.

2	247	1
2	123	1
2	61	1
2	30	0
2	15	1
2	7	1
2	3	1
	1	

Binary number → $(11110111)_2$

★ Binary number $(11110111)_2$ into decimal number.

1 1 1 1 0 1 1 1

$2^7 \quad 2^6 \quad 2^5 \quad 2^4 \quad 2^3 \quad 2^2 \quad 2^1 \quad 2^0$

$128 \times 1 \quad 64 \times 1 \quad 32 \times 1 \quad 16 \times 1 \quad 8 \times 0 \quad 4 \times 1 \quad 2 \times 1 \quad 1 \times 1$

$128 + 64 + 32 + 16 + 4 + 2 + 1$

$128 + 64 + 32 + 20 + 3$

247 Ans

4. Decimal number 625 into Binary number

~~2 | 625 1~~
~~2 | 312 0~~
~~2 | 251 1~~
~~2 | 125 1~~
~~2 | 62 0~~
~~2 | 31 1~~
~~2 | 15 1~~
~~2 | 7 1~~
~~2 | 3 1~~
~~1~~

2	625	1
2	312	0
2	156	0
2	78	0
2	38	1
2	19	1
2	9	1
	4	

2	9	1
2	4	0
2	2	0
	1	

Binary number → ~~[illegible]~~

→ $(1001110001)_2$

625 X 2 = 1.25   1
25 X 2 = 0.50   0
50 X 2 = 1.00   1
0 X 2 = 0   0

$(110101.101)_2$

5. Decimal number $(53.625)_{10}$ into Binary number.

2	53	1
2	26	0
2	13	1
2	6	0
2	3	1
	1	

.625 X 2 = 1.25   1
.25 X 2 = 0.50   0
.50 X 2 = 1.00   1
.00 X 2 = 0   0

$(110101)_2$ $(.1010)$

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53.625

Decimal number → $(110102.1010)_2$

6. ~~Binary~~ Decimal number $(24.46)_2$ into Binary number.

$$\begin{array}{r|ll} 2 & 24 & 0 \\ 2 & 12 & 0 \\ 2 & 6 & 0 \\ 2 & 3 & 1 \\ & 1 & \end{array}$$

$.46 \times 2 = 0.92 \quad 0$
$.92 \times 2 = 1.94 \quad 1$
$.94 \times 2 = 1.88 \quad 1$
$.88 \times 2 = 1.76 \quad 1$
$.76 \times 2 = 1.52 \quad 1$
$.52 \times 2 = 1.04 \quad 1$

(11000)

$(24.46)_2$

Decimal number = $(11000.0\overline{1})_2$

Octal Number :-

0, 1, 2, 3, 4, 5, 6, 7
8

Ex :- $(444)_{10}$

$$\begin{array}{r|ll} 8 & 444 & 4 \\ 8 & 55 & 7 \\ & 6 & \end{array}$$

Octal no = $(674)_8$ Ans

674

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Octal number to Decimal Conversion ?

(i) $(237)_{10} = (?)_8$

$$\begin{array}{r|ll} 8 & 237 & 5 \\ 8 & 29 & 5 \\ & 3 & \end{array}$$

$(355)_8$ Ans

(ii) $(120)_8 = (?)_{10}$

$$\begin{array}{r|l} 8 & 120 \\ 8 & 15 \\ & 1 \end{array}$$

$(170)_{10}$

1	7	0
8^2	8^1	8^0
64×1	8×7	1×0
64 +	56 +	0

120 Ans

1 2 0

8^2 8^1 8^0

$= (64 \times 1) + (8 \times 2) + (1 \times 0)$

$= 64 + 16$

$= (80)_{10}$

$(80)_{10} = (?)_8$

$$\begin{array}{r|ll} 8 & 80 & 0 \\ 8 & 10 & 2 \\ & 1 & \end{array}$$

$(120)_{10}$

Octal number to Binary number.

2^3 2^2 2^1 2^0

8 4 2 1

$(376)_8$

3	7	6
011	111	110

$(376)_8 = (011\ 111\ 110)_2$

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★ Decimal to Binary

2^6	2^5	2^4	2^3	2^2	2^1	2^0
64	32	16	8	4	2	1

Decimal	Binary				
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	1	0	1	0	
11	1	0	1	1	
12	1	1	0	0	
13	1	1	0	1	
14	1	1	1	0	
15	1	1	1	1	
16	1	0	0	0	0

Hexadecimal number (16)

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, (A, B, C, D, E, F)

10 = A
11 = B
12 = C
13 = D
14 = E
15 = F

Decimal to Hexa

(i) $(115)_{10} = (?)_{16}$

$16 \,|\, 115 \quad 3$
$\quad 7$

$(73)_{16}$ Ans

(ii) $(235)_{10} = (?)_{16}$

$16 \,|\, 235 \quad 11$ $\quad$ $14 = E$ $\quad$ $11 = B$
$\quad 14$

$(1411)_{16}$
$(EB)_{16}$

Hexadecimal to Binary (4 ka pair)

(i) $(2D5)_{16} = (?)_2$

2 D 5
$(0010 \quad 1101 \quad 0101)_2$

(ii) $(15)_{16} = (?)_2$

1 5
$(0001 \quad 0101)$

$(0001 \quad 0101)_2$

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Binary to Hexadecimal

(i) $(0111 \quad 1011 \quad 0101)_2 = (?)_{16}$

$\quad 7 \quad 11 \quad 5$

$(7B5)_{16}$

(ii) $(00\ 10 \quad 1110 \quad 1010) = (?)_{16}$

$\quad 2 \quad E \quad A$

$(2EA)_{16}$

(iii) $(0001 \quad 1110 \quad 1111 \quad 1100) = (?)_{16}$

$\quad 1 \quad E \quad F \quad C$

$(1EFC)_{16}$

Hexadecimal to octal

(i) $(47)_{16} = (?)_8$

$4 \quad 7$

$0100 \quad 0111$

$(001\ 000\ 111)_2$

$1 \quad 0 \quad 7$

$(107)_8$

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(ii) $(57)_{16} = (?)_8$

5 7
0101 0111

$(0\,0101\,0111)_2$
1 2 7

$(127)_8$

(iii) $(23)_{16} = (?)_8$

2 3
0010 0011

$(0\,0010\,0011)_2$

$(043)_8$

Octal to Hexadecimal

(i) $(32)_8 = (?)_{16}$

3 2
011 010

$(00\,011\,010)_2$
1 10

$(1A)_{16}$

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(ii) $(42)_8 = (?)_{16}$

4 2
100 010

$(\underbrace{0010}_{2}\underbrace{0010}_{2})_2$

$(22)_{16}$

(iii) $(33)_8 = (?)_{16}$

3 3
011 011

$(\underbrace{0001}_{1}\underbrace{1011}_{B})_2$

$(1B)_{16}$

Arithmetic Operation

★ Addition :-

$0 + 0 = 0$
$0 + 1 = 1$
$1 + 0 = 1$
$1 + 1 = 10$

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★ Subtract :-

0 - 0 = 0
10 - 1 = 01
1 - 0 = 1
1 - 1 = 0

★ Multiplication :-

0 X 0 = 0
0 X 1 = 0
1 X 0 = 0
1 X 1 = 1

★ Divide :-

0 X 1 = 0
1 X 1 = 1
1 X 0 } Not
0 X 0 } allowed

Add :-

(i)

```
   1 1 1 1 → 15
   1 0 1 0 → 10
 1 1 0 0 1   25
```

(ii)

```
   1 1 0 1 → 13
   1 0 0 1 → 9
 1 0 1 1 0   22
```

(iii)

```
   1 0 0 1
   1 1 0 0
 1 0 1 0 1
```

(iv)

```
   0 1 0 1
   1 1 0 0
 1 0 0 0 1
```

Subtract :-

(i)
$$\begin{array}{r} 1\;1\;0\;1 \\ -\,1\;0\;0\;1 \\ \hline 0\;1\;0\;0 \end{array}$$

(ii)
$$\begin{array}{r} 1\;1\;1\;1 \\ -\,0\;1\;0\;1 \\ \hline 1\;0\;1\;0 \end{array}$$

(iii)
$$\begin{array}{r} 1\;1\;0\;0 \\ -\,0\;1\;1\;0 \\ \hline 0\;1\;1\;0 \end{array}$$

Multiply :-

(i) 1011 (11) X 1101 (13) = 143

$$\begin{array}{r} 1\;0\;1\;1 \\ \times\;1\;1\;0\;1 \\ \hline 1\;0\;1\;1 \\ 0\;0\;0\;0\;\times \\ 1\;0\;1\;1\;\times\;\times \\ 1\;0\;1\;1\;\times\;\times\;\times \\ \hline 1\;0\;0\;0\;1\;1\;1\;1 \end{array} = 143$$

(ii) 101 X 101

$$\begin{array}{r} 1\;0\;1 \\ \times\;1\;0\;1 \\ \hline 1\;0\;1 \\ 0\;0\;0\;\times \\ 1\;0\;1\;\times\;\times \\ \hline 1\;1\;0\;0\;1 \end{array}$$

Divide :- 11001 ÷ 101

$$\begin{array}{r l} 101\,) & 1\;1\;0\;0\;1\;(\;1\;0\;1 \\ & 1\;0\;1 \\ \hline & 0\;0\;1\;0\;1 \\ & \quad\;\; 1\;0\;1 \\ \hline & \quad\;\; \times\;\times \end{array}$$

1s and 2s compliment :-

1 1 1 1
1 0 1 0

1st compliment substraction to binary numbers using the once compliment method allow substraction only by additions.

The once compliment of a binary number can be obtained by changing all 1s to 0 and all 0s to 1.

Two subtract a smaller number from a larger number the once compliment method is as follows.

(i) Determine the once (1s) compliment of the smaller number.

(ii) Add this to the larger number.

(iii) Remove the carry number and add it to the result this carry is called end around carry.

1111	1 1 1 1
1010	0 1 0 1
~~1000000~~	10 1 0 0
	+1
	101

In around carry.

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Subtract $(1010)_2$ from $(1000)_2$ using 1s compliment.

$$\begin{array}{r} 1010 \rightarrow 10 \\ -1000 \rightarrow 8 \\ \hline 0010 \quad 2 \end{array}$$

(i) 0010

(ii)
$$\begin{array}{r} 1010 \\ +0010 \\ \hline 1100 \end{array}$$

(iii)
$$\begin{array}{r} 1010 \\ 0010 \\ \hline 11 \end{array}$$

$(1010)_2 - (1000)_2$

(i) 0111

(ii) 1010 + 0111

$$\begin{array}{r} 1010 \\ +0111 \\ \hline 10001 \end{array}$$

Carry

(iii)
$$\begin{array}{r} 0001 \\ +1 \\ \hline 0010 \end{array}$$

2's compliment

→ The 2's compliment of a binary number can be obtained by adding 1 to its 1s' compliment.

Substraction of a smaller number from a larger one by the 2s' compliment method involves the following step.

(i) Determine the 2s' compliment of the smaller number.

(ii) Add this to the larger number.

(iii) Omit the carry.
छोड़ना

Subtract $(1010)_2$ from $(1111)_2$ using the 2s' complement.

1010 → 10
1111 → 15

(i)
0101
+1
0110

(ii)
1111
+0110
10101

1111
0110
(1)0101
omit

(iii) 0101

Subtract $(1010)_2$ from $(1000)_2$ using 2s' complement.

1010 → 10
1000 → 8

(i)
0111
+ 1
1000

(ii)
1010
1000
(1)0010
omit

(iii) 0010

→
1111 → 15
0101 → 5

(i)
1010
+ 1
1011

(ii) →
1111
1011
(1)1010
omit

(iii) 1010

BCD (Binary Code Decimal)

Decimal No.	Binary No.	Binary code Decimal
0	0000	0000
1	0001	0001
2	0010	0010
3	0011	0011
4	0100	0100
5	0101	0101
6	0110	0110
7	0111	0111
8	1000	1000
9	1001	1001
10	1010	0001 0000
11	1011	0001 0001
12	1100	0001 0010
13	1101	0001 0011
14	1110	0001 0100
15	1111	0001 0101

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Excess-3 code (add 3 in the decimal no. individual)

$$(6\ 4\ 3)_{10} \quad \begin{array}{ccc} 6 & 4 & 3 \\ +3 & +3 & +3 \\ \hline 9 & 7 & 6 \\ \downarrow & \downarrow & \downarrow \end{array} \quad (1001\ 0111\ 0110)_{BCD}$$

$$(9)_{10} \quad \begin{array}{c} 9 \\ +3 \\ \hline 12 \end{array} \quad (0001\ 0010)_{BCD}$$

ASCII Code :~

A standard code that has been widely accepted by the industry, the ASCII code stands for American standard code for information interchange, used in most microcomputer by its manufacturers.

The ASCII code represent a character with 7 bits, which can be store as one byte with one bit unused. The extra bit is oftend used to extend the ASCII code to represent an additional 128 characters.

Chara cter	7-bit ASCII
A	100 0001
B	100 0010
C	100 0011
D	100 0100
E	100 0101
F	100 0110
G	100 0111
H	100 1000
I	100 1001
J	100 1010
k	100 1011
L	100 1100
M	100 1101
N	100 1110
O	100 1111
P	101 0000
Q	101 0001
R	101 0010
S	101 0011
T	101 0100
U	101 0101
V	101 0110
W	101 0111
X	101 1000
Y	101 1001
Z	101 1010
0	011 0000
1	011 0010
2	011 0010
3	011 0011

4	011 0100
5	011 0101
6	011 0110
7	011 0111
8	011 1000
9	011 1001
Blank	010 0000
.	010 1110
(	010 1000
)	010 1001
+	010 0100
$	010 1010
*	010 1101
	010 1111
–	010 1100
/	010 1101
	010 0010

EBCDIC Code :~

Another alpha-numeric code used in IBM (Software company) equipment is the EBCDIC or extended Binary coded Decimal information code:
It differs from ASCII only in its code grouping for the different alpha-numeric characters.

It uses eight bits for each characters and ninth bit for parity.

BOOLEAN ALGEBRA :~

Mathematician George Boole invented a new kind of algebra - The algebra of logic in the year 1854 properly known as boolean algebra or switching algebra.

He states that symbol can be used to represent the structure of logical thought

The boolean expression are basically defined by stating that first a constant is a boolean expression and second a variable is a boolean expression.

For example:~ If A^1 is a boolean expression, so is $0 \leftarrow \bar{A}$. The combination of variables such as $\boxed{\bar{A}B \ \& \ \bar{A}B + C}$ are also boolean expression

However $\boxed{A-B}$ is not a boolean expression.