

(1)

3. Decimal to Binary :

1) Ans)
$$\begin{array}{r} 2 \overline{) 1920} \\ 2 \overline{) 960} - 0 \\ 2 \overline{) 480} - 0 \\ 2 \overline{) 240} - 0 \\ 2 \overline{) 120} - 0 \\ 2 \overline{) 60} - 0 \\ 2 \overline{) 30} - 0 \\ 2 \overline{) 15} - 0 \\ 2 \overline{) 7} - 1 \\ 2 \overline{) 3} - 1 \\ 1 - 1 \end{array}$$

$$1920_{10} = 11110000000_2$$

2)
$$\begin{array}{r} 2 \overline{) 255} \\ 2 \overline{) 127} - 1 \\ 2 \overline{) 63} - 1 \\ 2 \overline{) 31} - 1 \\ 2 \overline{) 15} - 1 \\ 2 \overline{) 7} - 1 \\ 2 \overline{) 3} - 1 \\ 1 - 1 \end{array}$$

$$255_{10} = 11111111_2$$

(2)

3) 126

$$\begin{array}{r}
 2 \overline{) 126} \\
 2 \overline{) 63-0} \\
 2 \overline{) 31-1} \\
 2 \overline{) 15-1} \\
 2 \overline{) 7-1} \\
 2 \overline{) 3-1} \\
 1-1
 \end{array}$$

$$126_{10} = 1111110_2$$

Decimal to Octal:

1) 1920

$$\begin{array}{r}
 8 \overline{) 1920} \\
 8 \overline{) 240-0} \\
 8 \overline{) 30-0} \\
 3-6
 \end{array}$$

$$1920_{10} = 3600_8$$

2) 255

$$\begin{array}{r}
 8 \overline{) 255} \\
 8 \overline{) 31-7} \\
 3-7
 \end{array}$$

$$255_{10} = 377_8$$

(3)

3) 126

$$\begin{array}{r} 8 \overline{) 126} \\ 8 \overline{) 15-6} \\ 1-7 \end{array}$$

$$126_{10} = 176_8$$

Decimal to Hexadecimal:

1) 1920

$$\begin{array}{r} 16 \overline{) 1920} \\ 16 \overline{) 120-0} \\ 7-8 \end{array}$$

$$1920_{10} = 780_{16}$$

2) 255

$$\begin{array}{r} 16 \overline{) 255} \\ 15-15 \end{array}$$

15-F

$$255_{10} = FF_{16}$$

3) 126

$$\begin{array}{r} 16 \overline{) 126} \\ 7-14 \end{array}$$

14-E

$$126_{10} = 7E_{16}$$

(4)

Binary to Decimal

1) 101110101

101110101

1	$\times 2^0 = 1$
0	$\times 2^1 = 0$
1	$\times 2^2 = 4$
0	$\times 2^3 = 0$
1	$\times 2^4 = 16$
1	$\times 2^5 = 32$
1	$\times 2^6 = 64$
0	$\times 2^7 = 0$
1	$\times 2^8 = 256$

 373

$$101110101_2 = 373_{10}$$

Checking:

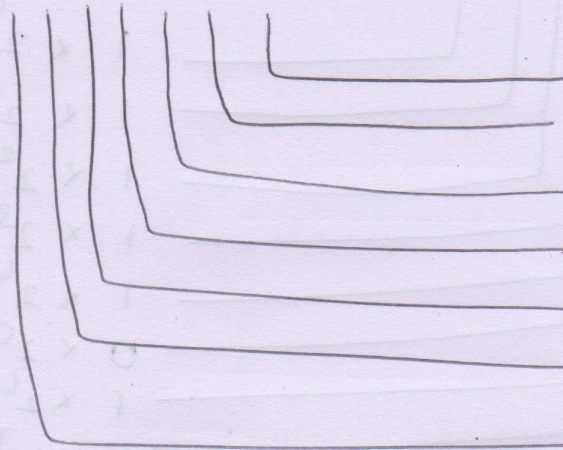
2	373
2	186 - 1
2	93 - 0
2	46 - 1
2	23 - 0
2	11 - 1
2	5 - 1
2	2 - 1
	1 - 0

(5)

2)

1011010

1011010



$$\begin{aligned}
 0 \times 2^0 &= 0 \\
 1 \times 2^1 &= 2 \\
 0 \times 2^2 &= 0 \\
 1 \times 2^3 &= 8 \\
 1 \times 2^4 &= 16 \\
 0 \times 2^5 &= 0 \\
 1 \times 2^6 &= 64
 \end{aligned}$$

 90

$$1011010_2 = 90_{10}$$

Checking:

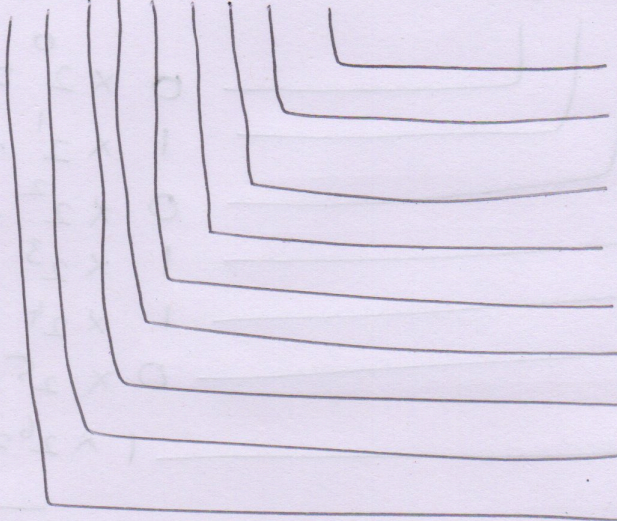
$$\begin{array}{r}
 2 \overline{) 90} \\
 \underline{2 \quad 45 - 0} \\
 2 \quad 22 - 1 \\
 \underline{2 \quad 11 - 0} \\
 2 \quad 5 - 1 \\
 \underline{2 \quad 2 - 1} \\
 1 - 0
 \end{array}$$

(6)

3)

101011111

101011111



$$1 \times 2^0 = 1$$

$$1 \times 2^1 = 2$$

$$1 \times 2^2 = 4$$

$$1 \times 2^3 = 8$$

$$1 \times 2^4 = 16$$

$$0 \times 2^5 = 0$$

$$1 \times 2^6 = 64$$

$$0 \times 2^7 = 0$$

$$1 \times 2^8 = 256$$

 351

$$101011111_2 = 351_{10}$$

Checking:

$$2 \overline{) 351}$$

$$2 \overline{) 175 - 1}$$

$$2 \overline{) 87 - 1}$$

$$2 \overline{) 43 - 1}$$

$$2 \overline{) 21 - 1}$$

$$2 \overline{) 10 - 1}$$

$$2 \overline{) 5 - 0}$$

$$2 \overline{) 2 - 1}$$

$$1 - 0$$

(9)

Binary to Octal:

1) 101110101

— Group into 3 bits right to left.

<u>101</u>	<u>110</u>	<u>101</u>
3 bits	3 bits	3 bits

$$\begin{array}{rcl}
 101 & & \\
 \begin{array}{l} \text{---} \\ \text{---} \\ \text{---} \end{array} & \begin{array}{l} 1 \times 2^0 \\ 0 \times 2^1 \\ 1 \times 2^2 \end{array} & \begin{array}{l} = 1 \\ = 0 \\ = 4 \end{array} \\
 & & \hline
 & & 5
 \end{array}$$

$$\begin{array}{rcl}
 110 & & \\
 \begin{array}{l} \text{---} \\ \text{---} \\ \text{---} \end{array} & \begin{array}{l} 0 \times 2^0 \\ 1 \times 2^1 \\ 1 \times 2^2 \end{array} & \begin{array}{l} = 0 \\ = 2 \\ = 4 \end{array} \\
 & & \hline
 & & 6
 \end{array}$$

$$\begin{array}{rcl}
 101 & & \\
 \begin{array}{l} \text{---} \\ \text{---} \\ \text{---} \end{array} & \begin{array}{l} 1 \times 2^0 \\ 0 \times 2^1 \\ 1 \times 2^2 \end{array} & \begin{array}{l} = 1 \\ = 0 \\ = 4 \end{array} \\
 & & \hline
 & & 5
 \end{array}$$

Ans:

$$101110101_2 = 565_8$$

27)

1011010

(8)

$$\begin{array}{r} 001 \\ \hline 3 \text{ bits} \end{array}$$

$$\begin{array}{r} 011 \\ \hline 3 \text{ bits} \end{array}$$

$$\begin{array}{r} 010 \\ \hline 3 \text{ bits} \end{array}$$

$$\begin{array}{r} 010 \\ \begin{array}{l} \text{---} \\ \text{---} \\ \text{---} \end{array} \end{array} \quad \begin{array}{l} 0 \times 2^0 = 0 \\ 1 \times 2^1 = 2 \\ 0 \times 2^2 = 0 \end{array} \\ \hline 2 \end{array}$$

$$\begin{array}{r} 011 \\ \begin{array}{l} \text{---} \\ \text{---} \\ \text{---} \end{array} \end{array} \quad \begin{array}{l} 1 \times 2^0 = 1 \\ 1 \times 2^1 = 2 \\ 0 \times 2^2 = 0 \end{array} \\ \hline 3 \end{array} \quad \begin{array}{r} 23 \\ 01-1 \\ \hline \end{array}$$

$$\begin{array}{r} 001 \\ \begin{array}{l} \text{---} \\ \text{---} \\ \text{---} \end{array} \end{array} \quad \begin{array}{l} 1 \times 2^0 = 1 \\ 0 \times 2^1 = 0 \\ 0 \times 2^2 = 0 \end{array} \\ \hline 1 \end{array}$$

$$1011010_2 = 132_8$$

Checking:

$$\begin{array}{r} 2 \overline{) 90} \\ 2 \overline{) 45-0} \\ 2 \overline{) 22-1} \\ 2 \overline{) 11-0} \\ 2 \overline{) 5-1} \\ 2 \overline{) 2-1} \\ 1-0 \end{array} \quad \begin{array}{r} 132 \\ \begin{array}{l} \text{---} \\ \text{---} \\ \text{---} \end{array} \end{array} \quad \begin{array}{l} 2 \times 8^0 = 2 \\ 3 \times 8^1 = 24 \\ 1 \times 8^2 = 64 \end{array} \\ \hline 90 \end{array}$$

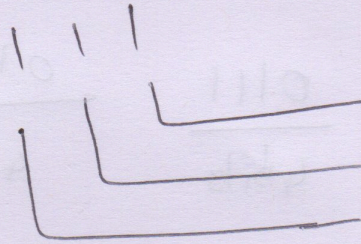
(9)

3)

10101111

$$\begin{array}{r} 101 \\ \hline 3 \text{ bits} \end{array}$$

$$\begin{array}{r} 011 \\ \hline 3 \text{ bits} \end{array}$$

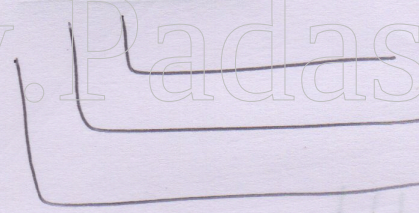
$$\begin{array}{r} 111 \\ \hline 3 \text{ bits} \end{array}$$


$$\begin{array}{rcl} 1 & \times 2^0 & = 1 \\ 0 & \times 2^1 & = 0 \\ 1 & \times 2^2 & = 4 \end{array}$$

$$\underline{5}$$

$$\begin{array}{r} 2 \overline{) 7} \\ 2 \overline{) 3-1} \\ \hline 1-1 \end{array}$$

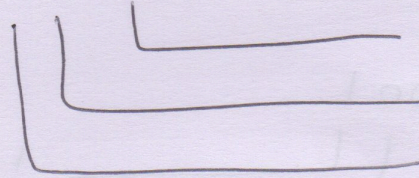
011



$$\begin{array}{rcl} 0 & \times 2^0 & = 0 \\ 1 & \times 2^1 & = 2 \\ 1 & \times 2^2 & = 4 \end{array}$$

$$\underline{6}$$

101



$$\begin{array}{rcl} 1 & \times 2^0 & = 1 \\ 0 & \times 2^1 & = 0 \\ 1 & \times 2^2 & = 4 \end{array}$$

$$\underline{5}$$
Ans:

$$10101111_2 = 537_8$$

(10)

Binary numbers to Hexadecimal number:

1) 101110101

— Group into 4 bits right to left.

$$\begin{array}{r} 0001 \\ \hline 4 \text{ bits} \end{array}$$

$$\begin{array}{r} 0111 \\ \hline 4 \text{ bits} \end{array}$$

$$\begin{array}{r} 0101 \\ \hline 4 \text{ bits} \end{array}$$

0101

1	$\times 2^0$	=	1
0	$\times 2^1$	=	0
1	$\times 2^2$	=	4
0	$\times 2^3$	=	0
			5

215
22-1
1-0

0111

1	$\times 2^0$	=	1
1	$\times 2^1$	=	2
1	$\times 2^2$	=	4
0	$\times 2^3$	=	0
			7

0001

1	$\times 2^0$	=	1
0	$\times 2^1$	=	0
0	$\times 2^2$	=	0
0	$\times 2^3$	=	0
			1

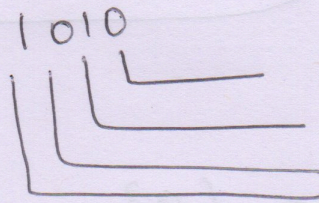
Ans:

$$101110101_2 = 175_{16}$$

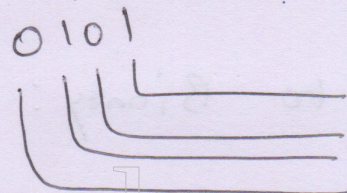
(11)

2) 1011010

$$\begin{array}{c} 0101 \\ \hline \text{bits} \end{array}$$

$$\begin{array}{c} 1010 \\ \hline \text{4bits} \end{array}$$


$$\begin{array}{rcl} 0 \times 2^0 & = & 0 \\ 1 \times 2^1 & = & 2 \\ 0 \times 2^2 & = & 0 \\ 1 \times 2^3 & = & 8 \\ \hline & & 10 \end{array}$$



$$\begin{array}{rcl} 1 \times 2^0 & = & 1 \\ 0 \times 2^1 & = & 0 \\ 1 \times 2^2 & = & 4 \\ 0 \times 2^3 & = & 0 \\ \hline & & 5 \end{array}$$

Ans:

$$1011010_2 = 5A$$

10-A

3) 10101111

$$\begin{array}{c} 0001 \\ \hline \text{4bits} \end{array}$$

$$\begin{array}{c} 0101 \\ \hline \text{4bits} \end{array}$$

$$\begin{array}{c} 1111 \\ \hline \text{4bits} \end{array}$$

$$\begin{array}{rcl} 1 \times 2^0 & = & 1 \\ 1 \times 2^1 & = & 2 \\ 1 \times 2^2 & = & 4 \\ 1 \times 2^3 & = & 8 \\ \hline & & 15 \end{array}$$

$$\begin{array}{rcl} 1 \times 2^0 & = & 1 \\ 0 \times 2^1 & = & 0 \\ 1 \times 2^2 & = & 4 \\ 0 \times 2^3 & = & 0 \\ \hline & & 5 \end{array}$$

Ans:

$$10101111_2 = 15F$$

15-F

$$\begin{array}{rcl} 1 \times 2^0 & = & 1 \\ \hline & & 1 \end{array}$$

$$\begin{array}{r} 215 \\ 27-1 \\ \hline 213-1 \\ \hline 1-1 \end{array}$$

(12)

Octal to Decimal:Ex: 1265_8

1 2 6 5

$$\begin{array}{r}
 5 \times 8^0 = 5 \\
 6 \times 8^1 = 48 \\
 2 \times 8^2 = 128 \\
 1 \times 8^3 = 512
 \end{array}$$

Ans:693

$$1265_8 = 693_{10}$$

Octal to Binary:A) 472_8

$$\begin{array}{r}
 2 \overline{) 7} \\
 2 \overline{) 3-1} \\
 \hline
 1-1
 \end{array}$$

$$\begin{array}{r}
 2 \overline{) 4} \\
 2 \overline{) 2-0} \\
 \hline
 1-0
 \end{array}$$

$$\begin{array}{r}
 2 \overline{) 2} \\
 \hline
 1-0
 \end{array}$$

→ 3 bits, Last 0 add

$$2_{10} = 010_2$$

$$7_{10} = 111_2$$

$$4_{10} = 100_2$$

Ans:

$$472_8 = 100111010_2$$

(13)

13) 145_8

$$\begin{array}{r} 2 \overline{) 5} \\ 2 \overline{) 2-1} \\ 1-0 \end{array}$$

$$5_{10} = 101_2$$

$$\begin{array}{r} 2 \overline{) 4} \\ 2 \overline{) 2-0} \\ 1-0 \end{array}$$

$$4_{10} = 100_2$$

$$\begin{array}{r} 2 \overline{) 1} \\ 1 \end{array}$$

$$1_{10} = 001_2$$

Ans:

$$145_8 = 001\ 100\ 101_2$$

(14)

c) 347_8

$$\begin{array}{r} 2 \overline{) 7} \\ 2 \overline{) 3-1} \\ \hline 1-1 \end{array}$$

$$7_{10} = 111_2$$

$$\begin{array}{r} 2 \overline{) 4} \\ 2 \overline{) 2-0} \\ \hline 1-0 \end{array}$$

$$4_{10} = 100_2$$

$$\begin{array}{r} 2 \overline{) 3} \\ 1-1 \end{array}$$

$$3_{10} = 011_2$$

Ans:

$$347_8 = 011100111_2$$

11) 6247_8

$$\begin{array}{r} 2 \overline{) 7} \\ 2 \overline{) 3-1} \\ 1-1 \end{array}$$

$$7_{10} = 111_2$$

$$\begin{array}{r} 2 \overline{) 4} \\ 2 \overline{) 2-0} \\ 1-0 \end{array}$$

$$4_{10} = 100_2$$

$$\begin{array}{r} 2 \overline{) 2} \\ 1-0 \end{array}$$

$$2_{10} = 010_2$$

$$\begin{array}{r} 2 \overline{) 6} \\ 2 \overline{) 3-0} \\ 1-1 \end{array}$$

$$6_{10} = 110_2$$

Ans:

$$6247_8 = 110010100111_2$$

E) 645_8

$$\begin{array}{r} 2 \overline{) 6} \\ 2 \overline{) 3-0} \\ 1-1 \end{array}$$

$$6_{10} = 110_2$$

$$\begin{array}{r} 2 \overline{) 4} \\ 2 \overline{) 2-0} \end{array}$$

$$\begin{array}{r} 1-0 \\ 4_{10} = 100_2 \end{array}$$

$$\begin{array}{r} 2 \overline{) 5} \\ 2 \overline{) 2-1} \\ 1-0 \end{array}$$

$$5_{10} = 101_2$$

$$645_8 = 110100101_{10}$$

(17)

Hexadecimal to Decimal numbers:

$$25F_{16}$$

$$25F(15)$$

$$\begin{array}{rcl} & & 0 \\ & & \text{---} 15 \times 16 = 15 \\ & & \text{---} 5 \times 16^1 = 80 \\ & & \text{---} 2 \times 16^2 = 512 \\ & & \hline & & 607 \end{array}$$

$$25F_{16} = 607_{10}$$

Hexadecimal to Binary:

$$8BC_{16}$$

$$8 \quad B(11) \quad C(12)$$

$$\begin{array}{r} 2 \overline{) 11} \\ 2 \overline{) 5-1} \\ 2 \overline{) 2-1} \\ 1-0 \end{array}$$

$$\begin{array}{r} 2 \overline{) 8} \\ 2 \overline{) 4-0} \\ 2 \overline{) 2-0} \\ 1-0 \end{array}$$

$$\begin{array}{r} 2 \overline{) 12} \\ 2 \overline{) 6-0} \\ 2 \overline{) 3-0} \\ 1-1 \end{array}$$

$$= 1011$$

$$= 1000_2$$

$$= 1100_2$$

Ans:

$$8BC = 101110001100_2$$

6.

(18)

A) A₆

A(10) 6

$$\begin{array}{r} 2 \overline{) 10} \\ 2 \overline{) 5-0} \\ 2 \overline{) 2-1} \end{array}$$

$$1-0$$

$$= 1010$$

$$\begin{array}{r} 2 \overline{) 6} \\ 2 \overline{) 3-0} \end{array}$$

$$1-1$$

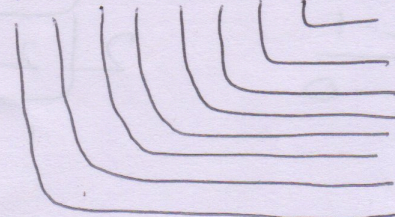
$$= 0110$$

Ans:

$$A6_{16} = 10100110_2$$

Checking: ① Binary to Decimal:

10100110



0	$\times 2^0$	=	0
1	$\times 2^1$	=	2
1	$\times 2^2$	=	4
0	$\times 2^3$	=	0
0	$\times 2^4$	=	0
1	$\times 2^5$	=	32
0	$\times 2^6$	=	0
1	$\times 2^7$	=	128
			166

② Decimal to Hexa:

$$\begin{array}{r} 16 \overline{) 166} \\ (A) 10-6 \end{array}$$

A6

(B) BE

$$\begin{array}{r} 2 \overline{) 11} \\ \underline{2} \\ 2 \overline{) 5-1} \\ \underline{2} \\ 2 \overline{) 2-1} \\ \underline{2} \\ 1-0 \end{array}$$

$$= 1011$$

$$\begin{array}{r} 2 \\ 2 \\ 2 \end{array} \overline{) 14} \begin{array}{r} 7 \\ 0 \\ 1 \end{array}$$

$$= 1110$$

$$BE_{16} = 1011110_2$$

Checking:

1 0 1 1 1 1 1 0

1	$\times 2^0$	=	0
1	$\times 2^1$	=	2
1	$\times 2^2$	=	4
1	$\times 2^3$	=	8
1	$\times 2^4$	=	16
1	$\times 2^5$	=	32
1	$\times 2^6$	=	0
0	$\times 2^7$	=	128

190

$$\begin{array}{r} 16 \overline{) 390} \\ 16 \overline{) 190} \end{array}$$

11-14

(B) (E)

$$11 \times 16 = 176$$

11 — B
14 — E

(20)

c) 9BC8

9 11(B) 12(C) 8

$$\begin{array}{r} 2 \overline{) 9} \\ 2 \overline{) 4 - 1} \\ 2 \overline{) 2 - 0} \\ 1 - 0 \end{array}$$

$$= 1001$$

$$\begin{array}{r} 2 \overline{) 11} \\ 2 \overline{) 5 - 1} \\ 2 \overline{) 2 - 1} \\ 1 - 0 \end{array}$$

$$= 1011$$

$$\begin{array}{r} 2 \overline{) 12} \\ 2 \overline{) 6 - 0} \\ 2 \overline{) 3 - 0} \\ 1 - 1 \end{array}$$

$$= 1100$$

$$\begin{array}{r} 2 \overline{) 8} \\ 2 \overline{) 4 - 0} \\ 2 \overline{) 2 - 0} \\ 1 - 0 \end{array}$$

$$= 1000$$

$$9BC8_{16} = 1001101111001000_2$$

Checking:

(1001101111001000)

$$\begin{array}{r} 16 \overline{) 39880} \\ 16 \overline{) 2492 - 8} \\ 16 \overline{) 155 - 12} \\ 9 - 11 \end{array}$$

$$\begin{aligned} &= 91128 \\ &= 9BC8 \end{aligned}$$

$$\begin{array}{l} 0 \times 2^0 = 0 \\ 0 \times 2^1 = 0 \\ 0 \times 2^2 = 0 \\ 1 \times 2^3 = 8 \\ 0 \times 2^4 = 0 \\ 0 \times 2^5 = 0 \\ 1 \times 2^6 = 64 \\ 1 \times 2^7 = 128 \\ 1 \times 2^8 = 256 \\ 1 \times 2^9 = 512 \\ 0 \times 2^{10} = 0 \\ 1 \times 2^{11} = 2048 \\ 1 \times 2^{12} = 4096 \\ 0 \times 2^{13} = 0 \\ 0 \times 2^{14} = 0 \\ 1 \times 2^{15} = 32768 \\ \hline 39880 \end{array}$$

~~14~~ (21)

D3

BC9

11 (B) 12 (C) 9

$= 1011 \quad = 1100 \quad = 1001$

BC9 = 1011 1100 1001₂
16

Checking:

1 0 1 1 1 1 0 0 1 0 0 1

$1 \times 2^0 = 1$
 $0 \times 2^1 = 0$
 $0 \times 2^2 = 0$
 $1 \times 2^3 = 8$
 $0 \times 2^4 = 0$
 $0 \times 2^5 = 0$
 $1 \times 2^6 = 64$
 $1 \times 2^7 = 128$
 $1 \times 2^8 = 256$
 $1 \times 2^9 = 512$
 $0 \times 2^{10} = 0$
 $1 \times 2^{11} = 2048$

3017

$16 \overline{) 3017}$
 $16 \overline{) 188 - 9}$

$11 - 12$
 (B) (C)

= BC9

$188 \times 16 = 3008$

$11 \times 16 = 176$

(22)

Fractional Decimal to Binary:

$(0.2)_{10}$

Integer Part

$0.2 \times 2 = 0.4$

 $0 \rightarrow$ (First Integer Part)

$0.4 \times 2 = 0.8$

0

$0.8 \times 2 = 1.6$

1

$0.6 \times 2 = 1.2$

1

$0.2 \times 2 = 0.4$

 $0 \rightarrow$ (Last Integer Part)

$(0.2)_{10}$

$= (0.01100011 \dots)_2$

Fractional Binary to Decimal:

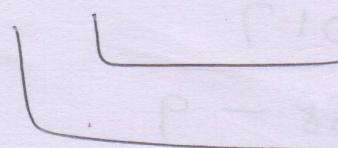
$(11.011)_2$

Integer Part:

$$\begin{array}{r} 2 \overline{) 11} \\ \underline{2} \\ 1 \end{array}$$

$$\begin{array}{r} 2 \overline{) 11} \\ \underline{2} \\ 1 \end{array}$$

11



$1 \times 2^0 = 1$

$1 \times 2^1 = 2$

$11_2 = 3_{10}$

$$\begin{array}{r} 1 \\ 2 \\ \hline 3 \end{array}$$

$$\begin{array}{rcl}
 1 & 1 & \cdot & 0 & 1 & 1 \\
 \swarrow & \downarrow & & \downarrow & \downarrow & \searrow \\
 1 & 0 & & -1 & -2 & -3 \\
 2 & 2 & \cdot & 2 & 2 & 2 \\
 \downarrow & \downarrow & & \downarrow & \downarrow & \downarrow \\
 2 & 1 & \cdot & \frac{1}{2} & \frac{1}{4} & \frac{1}{8} \\
 & & & \downarrow & \downarrow & \downarrow \\
 & & & 0.5 & 0.25 & 0.125 \\
 & & & 0.5 \times 0 & 0.25 \times 1 & 0.125 \times 1 \\
 2 & 1 & \cdot & 0 & 0.25 & 0.125
 \end{array}$$

$$(11.011)_2 = (2 + 1) + (0.25 + 0.125)$$

$$(11.011)_2 = (3.375)$$

$$\begin{array}{r}
 0.25 \\
 0.125 \\
 \hline
 0.375
 \end{array}$$

Positional
notation

weight

$$2^{-1} \left(\frac{1}{2} \right) \quad 0.5$$

$$2^{-2} \left(\frac{1}{4} \right) \quad 0.25$$

$$2^{-3} \left(\frac{1}{8} \right) \quad 0.125$$

$$2^{-4} \left(\frac{1}{16} \right) \quad 0.0625$$

(24)

Signed Representation:

2	43
2	21 - 1
2	10 - 1
2	5 - 0
2	2 - 1
	1 - 0

Signed binary

Number - 8 bits.

MSB
 ↳ 0 → Positive number

MSB
 ↳ 1 → Negative number

Positive

00101011
 ↓ ↳ LSB
 MSB

- 43

First Change 1's Complement:

Change 1 as 0 and 0 as 1

11010100

1's Complement
 ↳ Add 1 to LSB

11010101

Negative

(25)

1's Complement :

 $(-24)_{10}$

$$\begin{array}{r}
 2 \overline{) 24} \\
 \underline{24} \\
 00 \\
 2 \overline{) 12} \\
 \underline{12} \\
 00 \\
 2 \overline{) 6} \\
 \underline{6} \\
 00 \\
 2 \overline{) 3} \\
 \underline{3} \\
 00
 \end{array}$$

1 - 1
 00011000 → Binary No.

11100111 → 1's Complement no.
 MSB

2's Complement :

+ 24 Binary : 11000

8 bit format : 00011000

1's Complement : 11100111

2's Complement :

 11101000

Ex: 7

(26)

(A)

22

$$\begin{array}{r}
 2 \overline{) 22} \\
 \underline{2} \\
 0 \\
 2 \overline{) 11-0} \\
 \underline{2} \\
 0 \\
 2 \overline{) 5-1} \\
 \underline{4} \\
 1 \\
 2 \overline{) 2-1} \\
 \underline{2} \\
 0 \\
 1-0
 \end{array}$$

8 bit format = 00010110

(B)

13

$$\begin{array}{r}
 2 \overline{) 13} \\
 \underline{2} \\
 1 \\
 2 \overline{) 6-1} \\
 \underline{4} \\
 2 \\
 2 \overline{) 3-0} \\
 \underline{2} \\
 1-1
 \end{array}$$

8 bit = 00001101

1's Complement = 11110010

1 Add 1
to LSB

2's Complement = 11110011

(C) — 65

$$\begin{array}{r}
 2 \overline{) 65} \\
 \underline{2 32} - 1 \\
 2 \overline{) 16} - 0 \\
 2 \overline{) 8} - 0 \\
 2 \overline{) 4} - 0 \\
 2 \overline{) 2} - 0 \\
 1 - 0
 \end{array}$$

8 bit = 01000001

1's Complement = 10111110

2's Complement = $\begin{array}{r} 10111110 \\ + 1 \text{ (Add 1 to LSB)} \\ \hline 10111111 \end{array}$

(D) — 46

$$\begin{array}{r}
 2 \overline{) 46} \\
 \underline{2 23} - 0 \\
 2 \overline{) 11} - 1 \\
 2 \overline{) 5} - 1 \\
 2 \overline{) 2} - 1 \\
 1 - 0
 \end{array}$$

8 bit = 00101110

1's Com = 11010001

$$\begin{array}{r}
 11010001 \\
 + 1 \\
 \hline
 11010010
 \end{array}$$

(28)

Binary Addition:

$$0 + 0 = 0$$

$$0 + 1 = 1$$

$$1 + 0 = 1$$

$$1 + 1 = 10$$

→ Carry bit

Ex: 1

$$\text{Add: } 1011_2 + 1001_2$$

Carry Bit → 1 1

$$\begin{array}{r} 1011 \\ + 1001 \\ \hline 10100 \end{array}$$

Ex: 2

$$23_{10} + 12_{10}$$

$$\begin{array}{r} 2 \overline{) 23} \\ 2 \overline{) 11} - 1 \\ 2 \overline{) 5} - 1 \\ 2 \overline{) 2} - 1 \\ 1 - 0 \end{array}$$

$$23_{10} = 00010111$$

$$\begin{array}{r} 10111 \\ \begin{array}{l} \text{1} \times 2^0 = 1 \\ \text{1} \times 2^1 = 2 \\ \text{1} \times 2^2 = 4 \\ \text{0} \times 2^3 = 0 \\ \text{1} \times 2^4 = 16 \end{array} \\ \hline 23 \end{array}$$

→ 8 bit format:

(29)

$$\begin{array}{r}
 2 \overline{) 12} \\
 2 \overline{) 6} - 0 \\
 2 \overline{) 3} - 0 \\
 1 - 1
 \end{array}$$

1100

$$\begin{array}{r}
 0 \times 2^0 = 0 \\
 0 \times 2^1 = 0 \\
 1 \times 2^2 = 4 \\
 1 \times 2^3 = 8 \\
 \hline
 12
 \end{array}$$

$$12_{10} = 00001100 \rightarrow 8 \text{ bit format.}$$

Carry bit

111

$$23_{10} = 00010111$$

$$12_{10} = 00001100$$

$$35_{10} = 00100011$$

Checking:

$$\begin{array}{r}
 2 \overline{) 35} \\
 2 \overline{) 17} - 1 \\
 2 \overline{) 8} - 1 \\
 2 \overline{) 4} - 0 \\
 2 \overline{) 2} - 0 \\
 1 - 0
 \end{array}$$

$$35_{10} = 100011$$

(30)

Ex:3

$$(-21) + (5)_{10}$$

$$\begin{array}{r} 2 \overline{) 21} \\ 2 \overline{) 10} - 1 \\ 2 \overline{) 5} - 0 \\ 2 \overline{) 2} - 1 \\ 1 - 0 \end{array}$$

$$10101$$

$$\begin{array}{r} 1 \times 2^0 = 1 \\ 0 \times 2^1 = 0 \\ 1 \times 2^2 = 4 \\ 0 \times 2^3 = 0 \\ 1 \times 2^4 = 16 \\ \hline 21 \end{array}$$

$$8 \text{ bit} = 00010101$$

$$1's \text{ Complement} = 11101010$$

$$2's \text{ Complement} = 11101011$$

$$\begin{array}{r} 2 \overline{) 5} \\ 2 \overline{) 2} - 1 \\ 1 - 0 \end{array}$$

$$\begin{array}{r} 101 \\ 1 \times 2^0 = 1 \\ 0 \times 2^1 = 0 \\ 1 \times 2^2 = 4 \\ \hline 5 \end{array}$$

$$8 \text{ bit} = 00000101$$

$$-21_{10} = 11101011$$

$$5_{10} = 00000101$$

$$-16_{10} = 11110000$$

(31)

Checking:

$$\begin{array}{r}
 2 \overline{) 16} \\
 \underline{2} \\
 8 - 0 \\
 \underline{2} \\
 4 - 0 \\
 \underline{2} \\
 2 - 0 \\
 \underline{1} \\
 1 - 0
 \end{array}$$

$$8 \text{ bits} = 00010000$$

$$(-16)_{10}$$

$$15 = 11101111$$

$$-16_{10} = \underline{\underline{11110000}}$$

Ex: 8

(A)

$$10_{10} + 15_{10}$$

$$\begin{array}{r}
 2 \overline{) 10} \\
 \underline{2} \\
 8 - 0 \\
 \underline{2} \\
 6 - 1 \\
 \underline{2} \\
 4 - 0 \\
 \underline{1} \\
 1 - 0
 \end{array}$$

$$1010$$

$$\begin{array}{l}
 0 \times 2^0 = 0 \\
 1 \times 2^1 = 2 \\
 0 \times 2^2 = 0 \\
 1 \times 2^3 = 8 \\
 \hline
 10
 \end{array}$$

$$8 \text{ bits} = 00001010$$

(32)

$$\begin{array}{r}
 2 \overline{) 15} \\
 2 \overline{) 7-1} \\
 2 \overline{) 3-1} \\
 1-1
 \end{array}$$

$$\begin{array}{r}
 1111 \\
 1 \times 2^0 = 1 \\
 1 \times 2^1 = 2 \\
 1 \times 2^2 = 4 \\
 1 \times 2^3 = 8 \\
 \hline
 15
 \end{array}$$

$$8 \text{ bits} = 00001111$$

$$10_{10} = 00001010$$

$$15_{10} = 00001111$$

$$25_{10} = 00011001$$

Checking:

$$\begin{array}{r}
 2 \overline{) 25} \\
 2 \overline{) 12-1} \\
 2 \overline{) 6-0} \\
 2 \overline{) 3-0} \\
 1-1
 \end{array}$$

$$25_{10} = 11001$$

(33)

(B)

$$-12_{10} + 5_{10}$$

$$\begin{array}{r} 2 \overline{) 12} \\ 2 \overline{) 6 - 0} \\ 2 \overline{) 3 - 0} \\ 1 - 1 \end{array}$$

$$\begin{array}{r} 2 \overline{) 5} \\ 2 \overline{) 2 - 1} \\ 1 - 0 \end{array}$$

$$8 \text{ bits} = 00001100$$

$$= 00000101$$



1's Complement

$$11110011$$

1

$$\begin{array}{r} 11110100 \end{array} \rightarrow 2's \text{ Complement}$$

$$-12_{10} = 11110100$$

$$+5_{10} = 00000101$$

$$-7 = 11111001$$

$$\begin{array}{r} 2 \overline{) 7} \\ 2 \overline{) 3 - 1} \\ 1 - 1 \end{array}$$

Checking

$$\begin{array}{r} 8 \text{ bit } 00000111 \\ 11111000 - 1's \text{ com} \\ 1 \\ \hline 11111001 \rightarrow 2's \text{ com} \end{array}$$

I method

(34)

$$(C) \quad 14_{10} - 12_{10}$$

$$\begin{array}{r} 2 \overline{) 14} \\ 2 \overline{) 7-0} \\ 2 \overline{) 3-1} \\ 1-1 \end{array}$$

$$\begin{array}{r} 2 \overline{) 12} \\ 2 \overline{) 6-0} \\ 2 \overline{) 3-0} \\ 1-1 \end{array}$$

$$8 \text{ bits} = 00001110$$

$$= 00001100$$

$$14 \rightarrow 00001110$$

$$(-) \quad 12 \rightarrow 00001100$$

$$2 \rightarrow 00000010$$

Checking:

$$\begin{array}{r} 2 \overline{) 2} \\ 1-0 \end{array}$$

8 bits:

$$00000010$$

ii method

(35)

(c)

$$14_{10} - 12_{10}$$

$$\underline{14}$$

$$8 \text{ bits} = 00001110$$

$$\underline{-12}$$

$$\underline{8 \text{ bits}}$$

$$00001100$$

$$-12$$

$$1's \text{ Complement} = 11110011$$

$$2's \text{ Complement} = 11110100$$

$$+14 = 00001110$$

$$-12 = 11110100$$

$$+2 = 100000010$$

$$1100000010$$

→ bits are Overflow.

$$00000010$$

$$\begin{array}{r} 2 \quad 2 \\ \underline{1-0} \\ \hline \end{array}$$

(36)

$$D) (-2)_{10} - (-6)_{10}$$

$$\begin{array}{r} 2 \overline{) 2} \\ 1 - 0 \end{array}$$

8 bits = 00000010

$$\begin{array}{r} 2 \overline{) 6} \\ 2 \overline{) 3 - 0} \\ 1 - 0 \end{array}$$

00000110

$$\begin{array}{l} (-2)'s \text{ complement} = 11111101 \\ 2's \text{ complement} = \underline{11111110} \end{array}$$

$$\begin{array}{r} 111111 \\ -2 = 11111110 \\ +6 = 00000110 \end{array}$$

$$+4 = \underline{100000100}$$

$$\begin{array}{r} 1 \overline{) 00000100} \end{array}$$

→ bits are Overflow

Checking:

$$\begin{array}{r} 2 \overline{) 4} \\ 2 \overline{) 2 - 0} \\ 1 - 0 \end{array}$$

00000100

8bit format: