Subject: DLCA   **SEM: III**

Binary Arithmatics

• Rules for Binary Addition

Sum	carry
$0 + 0 = 0$	0
$0 + 1 = 1$	0
$1 + 0 = 1$	0
$1 + 1 = 0$	1

Example :-
```
    1 0 1 1
  +   1 0 0 1
  ─────────────
  1 │ 0 1 0 0
    ↓
  carry
```

• Rules for Binary Subtraction

Subtraction	Borrow
$0 - 0 = 0$	0
$0 - 1 = 1$	1
$1 - 0 = 1$	0
$1 - 1 = 0$	0

Example :-
```
    1 1 1 0
  -   1 0 1 1
  ─────────
    0 0 1 1
```

Decimal
14
-11
03

• Rules for Binary Multiplication

$0 \times 0 = 0$	
$0 \times 1 = 0$	
$1 \times 0 = 0$	
$1 \times 1 = 1$	

Example :-
```
        1 0 1
    ×   0 1 0
    ─────────
        0 0 0
  +   1 0 1 +
  + 0 0 0 + +
  ─────────────
  0 1 0 1 0
```

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• Rules for Binary Division

Example :-

$$11 \, \overline{)1100} \quad \underline{100}$$
$$\underline{-11}$$
$$000$$
$$\underline{-\quad 00}$$
$$00$$

* Binary Substraction
i) Using 1's Complement

1's Complement :- it can be obtained simply by changing all 1's to zero and all 0's to 1

Eg:- 10110 → 01001

Rules ⇒ 1) To subtract A-B
2) Find 1's complement of B.
3) Add 1's complement of B to A
4) if carry equal to 1 then add it to the result. it is called end around carry
5) if carry equal to 1 result is +ve & its in true form
6) if carry equal to 0 the result is -ve & is in 1's. complement so convert it in true form

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Ex i) $(10110)_2 - (10000)_2$

$\Rightarrow$ 1's Complement of 10000 $\rightarrow$ 01111
        Add 10110

$$+ \begin{array}{c} 10110 \\ 01111 \\ \hline 1\rceil 0010\phi \end{array}$$

↑ carry

carry = 1 ∴ Add 1 to Result

$$\therefore \begin{array}{c} 00101 \\ + \quad\quad 1 \\ \hline \boxed{00110} \end{array}$$

∴ $(10110)_2 - (10000)_2 = (00110)_2$

Ex 2) $(33)_{10} - (64)_{10}$

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

↑

$= (100001)_2$

2	64	0
2	32	0
2	16	0
2	8	0
2	4	0
2	2	0
	1	1

↑

$= (1000000)_2$

∴ $(100001)_2 - (1000000)_2$

1's complement of $(1000000)_2 \rightarrow 0111111$

Add $(100001)_2$

$$\begin{array}{c} 100001 \\ \hline 0 \mid 1100000 \end{array}$$

if carry = 0 ∴ Not in true form

∴ 1's complement of answer and −ve sign

∴ 1's complement of $1100000 \rightarrow (-0011111)_2$

$(-0011111)_2 = 0+0+1\times2^4+1\times2^3+1\times2^2+1\times2^1+1\times2^0$

$\qquad = 16+8+4+2+1$

$\qquad = (31)_{10}$

∴ $(33)_{10} - (64)_{10} = (-31)_{10}$

ii) Using 2's Complement

2's Complement :− 2's Complement of Binary no. can be obtained by adding 1 to 1's complement of that no.

Ex :− 1011

$$\begin{array}{ll} 0100 & \rightarrow \text{1's complement} \\ +\quad 1 & \rightarrow \text{Add 1} \\ \hline 0101 & \rightarrow \text{2's Complement.} \end{array}$$

Rules :- 1) To substract A - B.

2) Find 2's complement of B.

3) Add it to A

4) if carry is generated '1' then discard (ignore) carry.

5) if carry is 0 then answer will be -ve. & in 2's Complement form.

6) To get ans in true form take its 2's complement & give -ve sign.

Ex 1) $(50)_{10} - (2A)_{16}$

$(50)_{16} = $

2	50	6
2	25	1
2	17	1
2	8	0
2	4	0
2	2	0
		1

$(50)_{10} = $

2	50	0
2	25	1
2	12	0
2	6	0
2	3	1
	1	1

$= (110010)_2$

$(2A)_{16} = (0010\ 1010)_2$

$\therefore (110010)_2 - (00101010)_2$

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2's complement of (0010 1010)

$\qquad$ 1's complement $\rightarrow$ 11010101

$\qquad$ Add 1 $\qquad$ $+$ $\qquad$ 1

$\qquad$ $\overline{1 1 0 1 0 1 1 0}$

Now $\qquad$ 1 1 0 1 0 1 1 0

$+$ $\qquad$ 1 1 0 0 1 0

$\qquad$ $\overline{1 1 1 1 1 1}$

$\boxed{1}$ 0 0 0 0 1 0 0 0

$\downarrow$ Discard carry

$\therefore$ $(50)_{10} - (2A)_{16} = (0000 1000)_2$

Ex 2] $(7)_{10} - (15)_{10}$

$(7)_{10} = (0111)_2$, $(15)_{10} \rightarrow (1111)_2$

2's complement of $(1111)_2$

$\qquad$ 1's comp $\rightarrow$ 0000

$\qquad$ $+$ $\qquad$ 1

$\qquad$ $\overline{0001}$

Add   0001

+   0111

─────────────

0 | 1 0 0 0

↓

Carry = 0.   ∴ Take 2's complement of result
            & −ve sign

∴   For 2's complement of 1000

       1's complement 0111

                    +   1 1 1 1

                    ─────────────

                    $(-1000)_2$ = $(-8)_{10}$

∴ $(7)_{10} - (15)_{10}$ = $(-8)_{10}$