Week 7

Hexadecimal Addition

Hexadecimal Addition

Method :

1. In any column of an additional problem , think of the two hexadecimal digits in terms of their decimal values.
2. If the sum is 15 or less , bring down the corresponding hexadecimal digit.
3. If the sum is greater than 15 , then bring down the amount of the sum that exceeds 16 and carry “1” to the next column.

Hexadecimal Addition

Add the following hexadecimal numbers:

(a) $23_{16} + 16_{16}$ **(b)** $58_{16} + 22_{16}$ **(c)** $2B_{16} + 84_{16}$ **(d)** $DF_{16} + AC_{16}$

Solution

(a)
$$\begin{array}{r} 23_{16} \\ +16_{16} \\ \hline \mathbf{39}_{16} \end{array}$$
right column: $3_{16} + 6_{16} = 3_{10} + 6_{10} = 9_{10} = 9_{16}$
left column: $2_{16} + 1_{16} = 2_{10} + 1_{10} = 3_{10} = 3_{16}$

(b)
$$\begin{array}{r} 58_{16} \\ +\ 22_{16} \\ \hline \mathbf{7A}_{16} \end{array}$$
right column: $8_{16} + 2_{16} = 8_{10} + 2_{10} = 10_{10} = A_{16}$
left column: $5_{16} + 2_{16} = 5_{10} + 2_{10} = 7_{10} = 7_{16}$

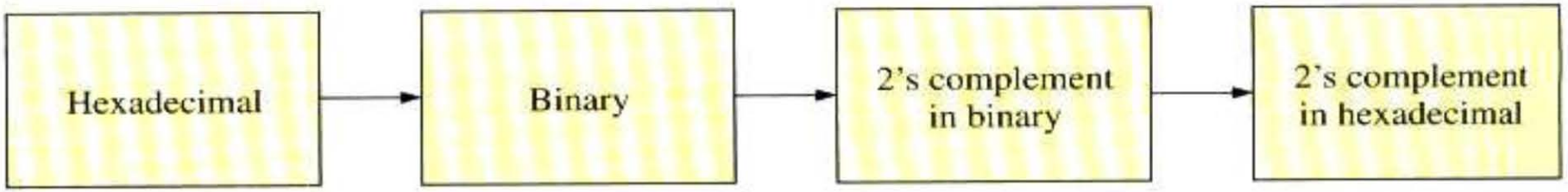
(c)
$$\begin{array}{r} 2B_{16} \\ +\ 84_{16} \\ \hline \mathbf{AF}_{16} \end{array}$$
right column: $B_{16} + 4_{16} = 11_{10} + 4_{10} = 15_{10} = F_{16}$
left column: $2_{16} + 8_{16} = 2_{10} + 8_{10} = 10_{10} = A_{16}$

(d)
$$\begin{array}{r} DF_{16} \\ +\ AC_{16} \\ \hline \mathbf{18B}_{16} \end{array}$$
right column: $F_{16} + C_{16} = 15_{10} + 12_{10} = 27_{10}$
$27_{10} - 16_{10} = 11_{10} = B_{16}$ with a 1 carry
left column: $D_{16} + A_{16} + 1_{16} = 13_{10} + 10_{10} + 1_{10} = 24_{10}$
$24_{10} - 16_{10} = 8_{10} = 8_{16}$ with a 1 carry

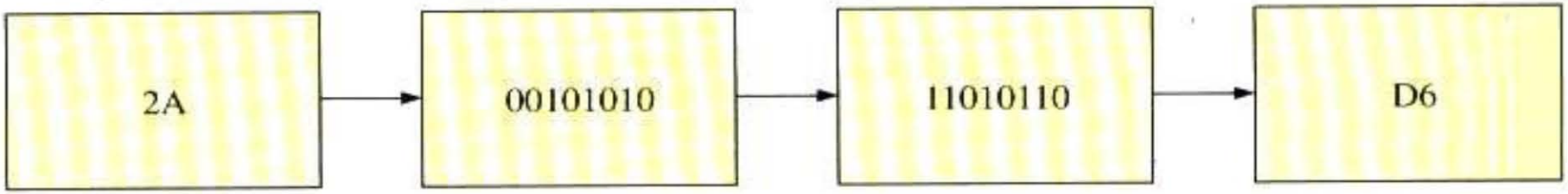
Hexadecimal Subtraction

Method -1- :

1. Convert the hexadecimal number to binary , then :
2. Get the 2nd complement of the subtrahend and add it to minuend.
3. Convert the result into hexadecimal.



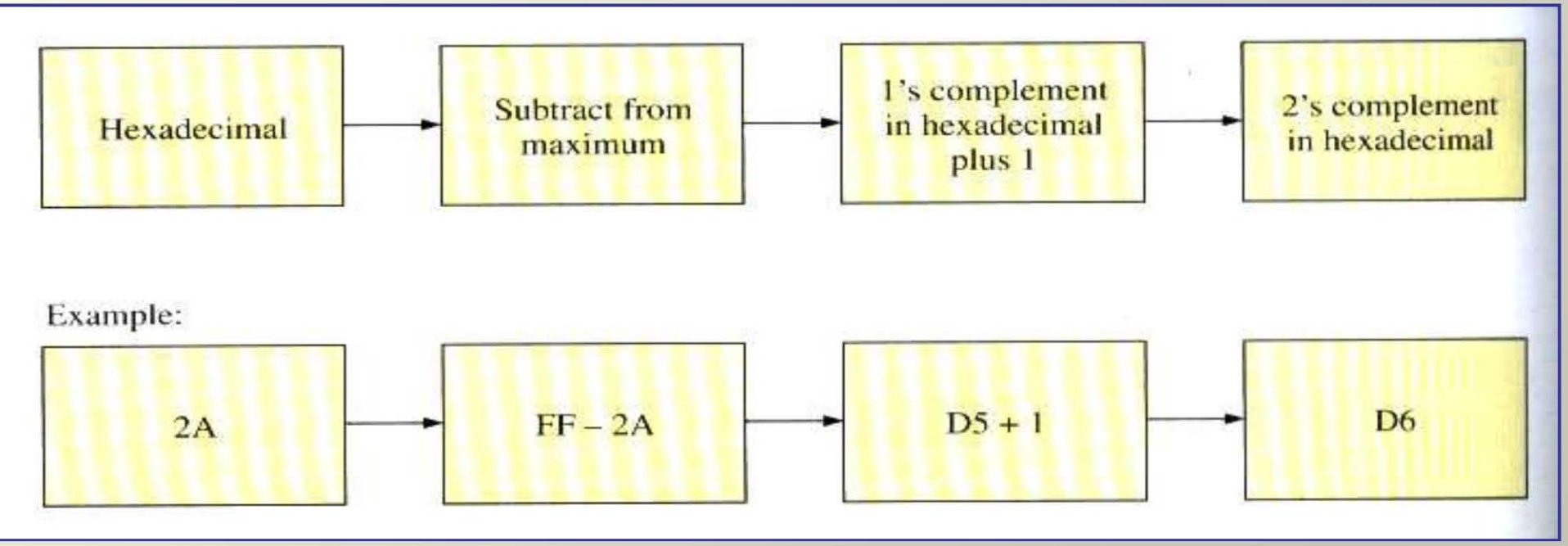
Example:



Hexadecimal Subtraction

Method -2- :

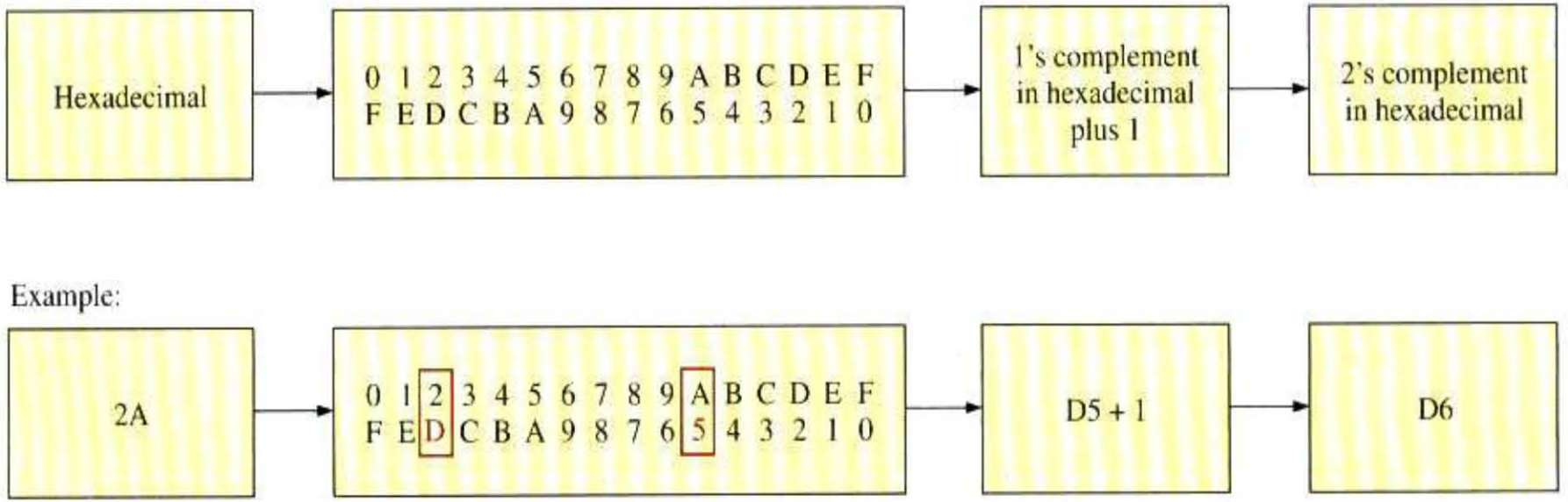
1. **Get the 2nd complement of the subtrahend by Subtracting it from the maximum hexadecimal number and add "1" .**
2. **Add the 2nd complement to the minuend.**



Hexadecimal Subtraction

Method -3- :

1. Get the 2nd complement of the subtrahend by:
   1. Write the hexadecimal digits and its reverse directly below it .
   2. Find out the 1st complement in hexadecimal by taking the associated reversed hexadecimal of the subtrahend.
   3. Add the 1 to the 1st hexadecimal complement
2. Add the 2nd complement to the minuend.



Hexadecimal Subtraction

Subtract the following hexadecimal numbers:

(a) $84_{16} - 2A_{16}$ **(b)** $C3_{16} - 0B_{16}$

Solution

(a) $2A_{16} = 00101010$

2's complement of $2A_{16} = 11010110 = D6_{16}$ (using Method 1)

$$\begin{array}{rl} 84_{16} & \\ +\ D6_{16} & \text{Add} \\ \hline \not{1}5A_{16} & \text{Drop carry, as in 2's complement addition} \end{array}$$

The difference is $\mathbf{5A}_{16}$.

(b) $0B_{16} = 00001011$

2's complement of $0B_{16} = 11110101 = F5_{16}$ (using Method 1)

$$\begin{array}{rl} C3_{16} & \\ +\ F5_{16} & \text{Add} \\ \hline \not{1}B8_{16} & \text{Drop carry} \end{array}$$

The difference is $\mathbf{B8}_{16}$.

11- Octal Numbers

The Octal number system has 8 digits.

These are : 0 , 1, 2 , 3, 4 , 5 , 6, 7

The Octal system has the base = 8

Binary number can easily be converted to octal by grouping 3 bits at a time and writing the equivalent octal character for each group.

Express $1\ 001\ 011\ 000\ 001\ 110_2$ in octal:

Group the binary number by 3-bits starting from the right. Thus, 113016_8

Decimal	Octal	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	10	1000
9	11	1001
10	12	1010
11	13	1011
12	14	1100
13	15	1101
14	16	1110
15	17	1111

Octal Numbers

The Octal system has the base = 8

Column weights { 8^3 8^2 8^1 8^0
512 64 8 1

Express 3702_8 in decimal.

Start by writing the column weights:

512 64 8 1

3 7 0 2_8

3(512) + 7(64) +0(8) +2(1) = 1986_{10}

Decimal	Octal	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	10	1000
9	11	1001
10	12	1010
11	13	1011
12	14	1100
13	15	1101
14	16	1110
15	17	1111

12- Binary Coded Decimal (BCD)

Binary Coded Decimal **BCD** system is an excellent way to provide an interface between Binary and Decimal System.

DECIMAL DIGIT	0	1	2	3	4	5	6	7	8	9
BCD	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001

Convert Decimal Numbers to BCD

Convert each of the following decimal numbers to BCD:

(a) 35 **(b)** 98 **(c)** 170 **(d)** 2469

Solution

(a) 3 5 → **00110101**

(b) 9 8 → **10011000**

(c) 1 7 0 → **000101110000**

(d) 2 4 6 9 → **0010010001101001**

Related Problem Convert the decimal number 9673 to BCD.