NUMBER SYSTEM

For Class- B.Pharmacy 2nd Semester

Subject- COMPUTER APPLICATIONS IN PHARMACY (BP205T)

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CONVERSION BINARY TO OCTAL

In order to convert binary number into octal number first separate digits of binary number into groups of 4 bits and then find equivalent octal number of each group (4 bits). Then, write all the group's octal number together maintaining the group order.

Binary to Octal Conversion

Convert the binary number 111110011001_2 to its octal equivalent.

1. ***Separate the digits of a given binary number into groups from right to left side, each containing 4 bits.***

   111 110 011 001

2. ***Find the equivalent octal number for each group.***

111	110	011	001
7	6	3	1

3. ***Write the all group's octal numbers together, maintaining the group order provides the equivalent octal number for the given binary.***

   7631

Result

$111110011001_2 = 7631_8$

CONVERSION HEXADECIMAL TO BINARY

To convert hexadecimal numbers to binary, you have to remember equivalent binary numbers for the first 16 hex digits. For example In order to represent hexadecimal number 12 you can use binary 1100 or hex value C.

Example:

Hexadecimal Number = 9 A F

Binary Number = 1001 for 9 1101 for A 1111 for F

So, number comes out to be 100110101111_2

Hexadecimal (base 16) to Binary (base 2) and reverse

Example: Start with $CE45_{16}$

C E 4 5

1100 1110 0100 0101

1100111001000101_2

Example: Start with 010111110000101_2

(0)010 1111 1000 0101

2 F 8 5

$2F85_{16}$

CONVERSION BINARY TO HEXADECIMAL

In order to convert binary number into hexadecimal, you have to make 4-bit groups and convert them directly into hex values.

To convert binary numbers into hexadecimals, you only have to make 4-bit groups and convert directly each group:

1011 0011 0101 (binary)

B 3 5 (hex)

Binary 0011 1001 1010 0010

Hexadecimal 3 9 A 2

Binary 0010 1011 1000 0001 . 1001 1000

Hexadecimal 2 D 8 1 . 9 8

To conclude, we can say that each of these equivalents can be converted into the other. The following table shows various values in different number systems.

Decimal, Binary, Octal, Hexidecimal Values

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

BINARY ADDITION

Binary Addition is similar to normal method of addition except the fact that it carries a value of 2 instead of 10. This is because in binary number system 2 is represented as 10.

IN BINARY SYSTEM, ADDITION HAS FOLLOWING RULES

Case	A + B	Sum	Carry
1	0 + 0	0	0
2	0 + 1	1	0
3	1 + 0	1	0
4	1 + 1	0	1

Example –

1. Suppose we have to add 10010 and 1001

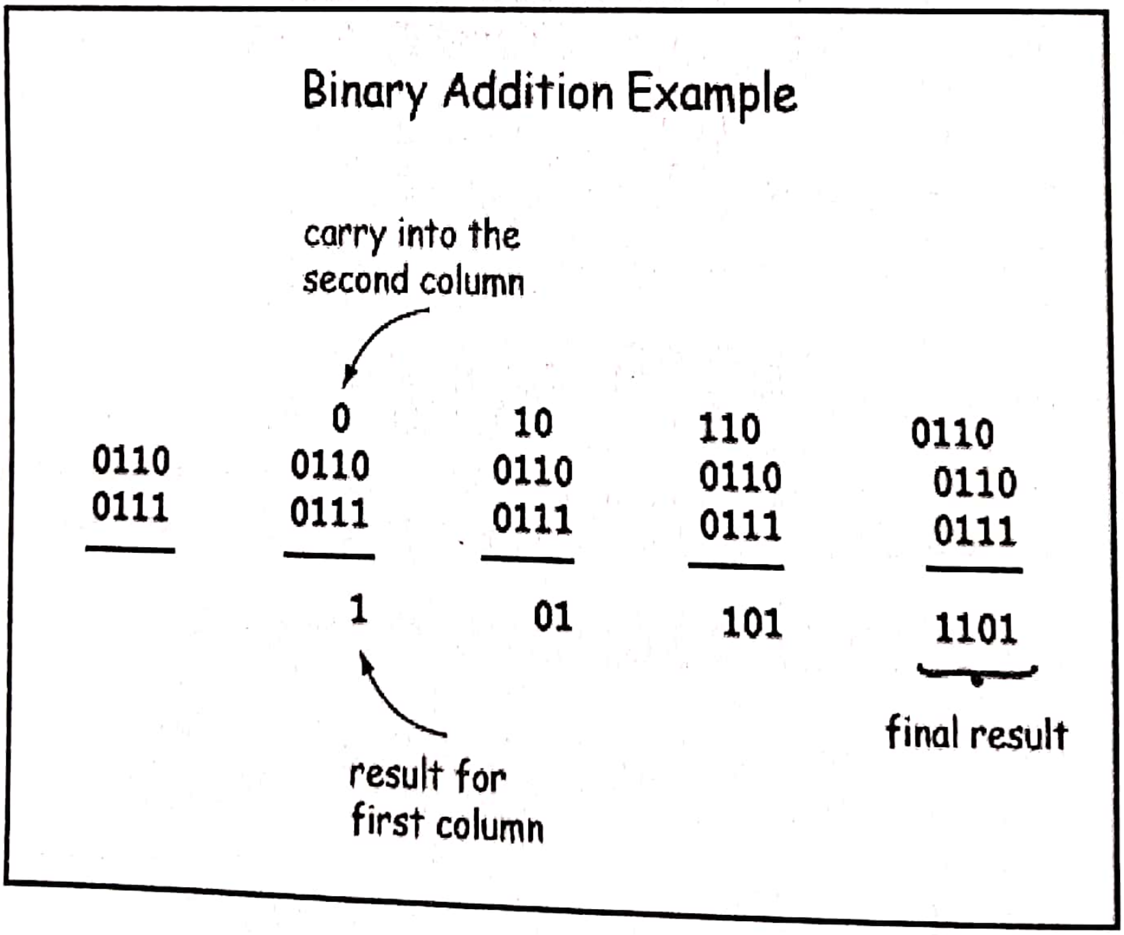
It will be calculated as

```
             1 0 0 1 0
            + 1 0 0 1
Answer is    1 1 0 1 1
```

2. Suppose we have to add 00111 and 10101

It will be calculated as

```
             0 1 1 1     (carried forward values)
             0 0 1 1 1
           + 1 0 1 0 1
Answer is    1 1 1 0 0
```



BINARY SUBTRACTION

Binary subtraction is also similar to that of normal subtraction except the fact that when 1 is subtracted from 0, it is borrowed from next higher order bit and that bit is reduced by 1.

BINARY SUBTRACTION TABLE

-	0	1
0	0	1
1	1	0

Case	A	-	B	Subtract	Borrow
1	0	-	0	0	0
2	1	-	0	1	0
3	1	-	1	0	0
4	0	-	1	0	1

Example:

1. Suppose we have to subtract 101 from 1001

It will be calculated as

1 (borrowed)
1 0 0 1
- 1 0 1

Answer is **1 0 0**

2. Suppose we have to subract 111 from 1000

It will be calculated as

1 (borrowed)
1 0 0 0
- 1 1 1

Answer is **0 0 0 1**

Binary Subtraction

Example:
Subtract binary number 101 from 1011

```
(borrow)
 0 1
  1 0 1 1
-   1 0 1
  -------
  0 1 1 0
```

ONE'S COMPLEMENT METHOD

The ones' complement of a binary number is defined as the value obtained by inverting all the bits in the binary representation of the number (swapping 0s for 1s and vice versa).

In this method, we subtract two binary numbers using carried by 1's complement.

Example:

(i) 110101 – 100101

Solution:

1's complement of 100101 is 011010.

Written as		1	1	0	1	0	1

1's complement of 110101 is 011010

Written as		0	1	1	0	1	0
Carry over -	1	0	0	1	1	1	1

Answer is **0 1 0 0 0 0**

(ii) 101011 – 111001

Solution:

1's complement of 111001 is 000110.

Written as 1 0 1 0 1 1

1's complement of 101011 is 000110

Written as 0 0 0 1 1 0

Answer is **110001**

Example of 1's complement

Subtract $(1010)_2$ from $(1111)_2$

Direct Subtraction

```
  1 1 1 1
- 1 0 1 0
---------
  0 1 0 1
```

1's complement method

```
                      1 1 1 1
1's complement  →   + 0 1 0 1
                    ---------
Carry           →   1 0 1 0 0
Add Carry       →           1
                    ---------
                      0 1 0 1
```

TWO'S COMPLEMENT METHOD

In order to get two's complement of a negative notation of an integer, we should write out the number in binary system and then invert its digits. Add one to the end result.

Example:

(i) 110110 - 10110

Solution:

The numbers of bits in the subtrahend is 5 while that of minuend is 6. We make the number of bits in the subtrahend equal to that of minuend by taking a `0' in the sixth place of the subtrahend.

Now, 2's complement of 010110 is (101101 + 1) i.e.101010. Adding this with the minuend.

	1 1	0	1	1	0	Minuend		
	1 0	1 0	1 0	2's	complement	of	subtrahend	
Carry over	1	1 0	0	0	0	0	Result of	addition

After dropping the carry over we get the result of subtraction to be 100000.

(ii) 10110 – 11010

Solution:

2's complement of 11010 is (00101 + 1) i.e. 00110. Hence

Minued	-	1	0	1	1	0
2's complement of subtrahend	-	0	0	1	1	0
Result of addition	-	1	1	1	0	0

As there is no carry over, the result of subtraction is negative and is obtained by writing the 2's complement of 11100 i.e.(00011 + 1) or 00100.

Hence the difference is – 100.

2's Complement Subtraction

- Two's complement subtraction is the binary addition of the minuend to the 2's complement of the subtrahend (adding a negative number is the same as subtracting a positive one).
- *For example,*

```
7 - 12 = (-5)      0000 0111  =  +7
                 + 1111 0100  =  -12
                 -----------
                   1111 1011  =  -5
```

BINARY MULTIPLICATION

The multiplication of binary numbers is carried out by multiplying multiplicand with one bit of the multiplier at a time and result of the partial product for each bit is placed in such a manner that the LSB is under the corresponding multiplier bit. Finally the partial products are added to get the complete product.

The rules of binary multiplication are given below –

Case	A x B	Multiplication
1	0 x 0	0
2	0 x 1	0
3	1 x 0	0
4	1 x 1	1

```
      1010   ——→  Multiplicand
    × 1011   ——→  Multiplier
   ________
      1010   ——→  Partial product 1
     1010    ——→  Partial product 2
    0000     ——→  Partial product 3
   1010      ——→  Partial product 4
   ________
   1101110
   ________
```

Example:

(i) 10111 by 1101

Solution:

```
      1 0 1 1 1
        1 1 0 1
      1 0 1 1 1        ← First partial product
    1 0 1 1 1
    1 1 1 0 0 1 1      ← First intermediate sum
  1 0 1 1 1
1 0 0 1 0 1 0 1 1      ← Final sum.
```

Hence the required product is 100101011.

Binary Multiplication

- Multiplication follows the general principal of shift and add.
- The rules include:
  - 0 * 0 = 0
  - 0 * 1 = 0
  - 1 * 0 = 0
  - 1 * 1 = 1

BINARY DIVISION

Division in binary system is same as in decimal system. But, in case of binary numbers, the quotient should be either 1 or 0 depending upon the divisor.

Binary Division Table

A / B	
0 / 1	0
1 / 1	1

```
101 ) 11010 ( 101 ⟶ Quotient
      101
      -----
        110
        101
      -----
          1  ⟶ Remainder
```

Example:

(i) 11001 ÷ 101

Solution:

```
101) 11001 (101
     101
     -----
       101
       101
     -----
```

Hence the quotient is 101

Binary Division

Divide the binary number A = 1010_2 by B = 10_2

```
      101
10) 1010
    10
  -------
     010
      10
  -------
       0
  -------
```

In order to summarize the given number systems, we can say that various number systems are used to represent different values. These are highlighted as below –