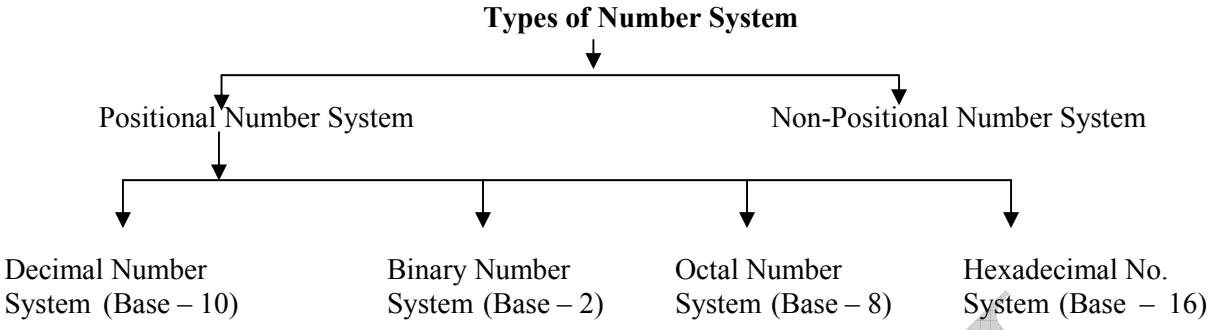
Number System



TYPES OF NUMBER SYSTEM

1. **Non-Positional Number System:** Each symbol represents the same value regardless of its position in the number and the symbols are simply added to find out the value of a particular number. Symbols in Non-Positional Number System are I for 1, II for 2, III for 3, IIII for 4, IIIII for 5 etc.
2. **Positional Number System**
    - There are only a few symbols called digits.
    - Each symbol represents different values depending on the position they occupy in the number.
    - Value of each digit in a number is determined by three considerations:
        - The digit itself.
        - The position of the digit in the number.
        - The base of the number system.

a) **Decimal Number System:** In this system, the base is equal to 10 because there are altogether ten symbols or digits used in the system (0,1,2,3,4,5,6,7,8,9).

b) **Binary Number System:** In this system, the base is equal to 2 because there are altogether two symbols or digits to represent a number (0, 1).

c) **Octal Number System:** In this system, the base is equal to 8 because there are altogether eight symbols or digits to represent a number (0, 1, 2, 3, 4, 5, 6, and 7).

d) **Hexadecimal Number System:** In this system, the base is equal to 16 because there are altogether sixteen symbols or digits to represent a number. The first 10 digits are the digits of a decimal system (0,1,2,3,4,5,6,7,8,9) and the remaining digits are represented by (A,B,C,D,E,F).

Converting from one Number System to another Number System:

(i) Conversion from Decimal to another Base System:

Using Division Remainder Technique

Step – I: Divide the decimal number to be converted by the value of the new base.

Step – II: Record the remainder from Step – I as right most digit of the new base number.

Step –III: Divide the quotient of the previous divide by the new base.

Step –IV: Record the remainder from Step – III as the next digit (of the left) of the new number.

Repeat Steps III & IV, recording remainders from right to left until the quotient becomes zero in Step – III. Note that the last remainder obtained will be the MSD (Most Significant Digit) of the new number.

For Example:

$(98)_{10} = (\ )_2$

1) Divide 98 by 2, making note of the remainder. Continue dividing quotients by 2, making note of the remainders. Also note the star (*) beside the last remainder.

Division	Remainder, R
98 / 2 = 49	R=0
49 / 2 = 24	R=1
24 / 2 = 12	R=0
12 / 2 = 6	R=0
6 / 2 = 3	R=0
3 / 2 = 1	R=1
1 / 2 = 0	R=1*

2) The sequence of remainders going up gives the answer. Starting from 1*, we have 1100010. Therefore, 98 in decimal is 1100010 in binary.

(ii) Converting to Decimal from another Base System:

Step – I: Determine the column value of each digit.

Step –II: Multiply the obtained column values by the digits in the corresponding column.

Step –III: Sum the products calculated in Step – II. The total is the equivalent value in decimal.

For Example:

$(11001)_2 = (\ )_{10}$
$1 \text{ X } 2^{4+} 1 \text{ X } 2^3 + 0 \text{ X } 2^2 + 0 \text{ X } 2^1 + 1 \text{ X } 2^0$
$16+8+0+0+1 = (25)_{10}$

$(4706)_8 = (\ )_{10}$
$4 \text{ X } 8^{3+} 7 \text{ X } 8^2 + 0 \text{ X } 8^1 + 6 \text{ X } 8^0$
$2048+448+0+6 = (2502)_{10}$

$(1AC)_{16} = (\ )_{10}$
$(11012)_{16} = (\ )_{10}$
$1 \text{ X } 16^{2+} 10 \text{ X } 16^1 + 12 \text{ X } 16^0$
$256+160+12 = (428)_{10}$

(iii) Converting from Base other than 10 to a Base other than 10:

Step – I: Convert the original number to a decimal number using expanded value method.

Step – II: Convert the decimal number so obtained to new base using Division Remainder Technique.

(iv) Shortcut Method for Binary to Octal Conversion:

Step – I: Divide the Binary digit into group of three starting from the right most digit.

Step –II: Convert each group of three Binary Digits into one Octal Digit.

For Example:

$(101110)_2 = (\ )_8$

$\underline{(101\ 110)}_2$

$= (56)_8$

0	1	2	3	4	5	6	7
000	001	010	011	100	101	110	111

(v) Shortcut Method for Octal to Binary Conversion.

Step – I: Convert each octal digit into three digit Binary Number.

Step –II: Combine all the resulting Binary Groups into a Single Binary Number.

For Example:

$(562)_8 = (\ )_2$ 5 = 101 6 = 110 2 = 010

$(101\ 110\ 010)_2$

(vi) Shortcut Method for Binary to Hexadecimal Conversion

Step – I: Divide the Binary digit into group of four starting from the right most digit.

Step –II: Convert each group of four Binary Digits into one Hexadecimal Digit.

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111

For Example:

$\underline{(1101\ 0011)}_2 = (\ )_{16}$ 1101 = D 0011 = 3

$(D3)_{16}$

(vii) Shortcut Method for Hexadecimal to Binary Conversion:

Step – I: Convert the Decimal equivalent of each Hexadecimal digit to four Binary Digits.

Step –II: Combine all the resulting Binary Groups into a Single Binary Number.

For Example:

$(2AB)_{16} = (\ )_2$

2 = 0010 A = 1010 B=1011

$(001010101011)_2$

Practical Problems:

Q:1 Find the Decimal, Octal and Hexadecimal Equivalent of the following Binary Numbers.

(a) 1101011
(b) 10110011
(c) 11010
(d) 11011101
(e) 1110101
(f) 1000
(g) 10110001100
(h) 1010101100
(i) 110001
(j) 111

Q:2 Convert the following numbers to Decimal.

(a) $(110110)_2$ (b) $(2573)_8$

(c) $(2A3B)_{16}$ (d) $(1234)_8$

Q:3 Convert the following Decimal Numbers to Binary, Octal and Hexadecimal.

(a) $(435)_{10}$ (b) $(1694)_{10}$

(c) $(321)_{10}$ (d) $(135)_{10}$

Q:4 Convert the following numbers to their Binary Equivalents.

(a) $(2AC)_{16}$ (b) $(FAB)_{16}$

(c) $(2614)_8$ (d) $(562)_8$

Q:5 Find Decimal Equivalents of the following numbers.

(a) $(111.01)_2$ (b) $(1001.011)_2$

(c) $(247.65)_8$ (d) $(A2B.D4)_{16}$

Best of luck,

Niti Bansal, M.Phil, MCA
c/o CA Jatin Bansal Classes
Chandigarh
9814622848, 9814098480