

مادة تقنيات الحاسبة

قسم علوم الحاسبات/كلية التربية/الجامعة المستنصرية

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استاذ المادة: م.د.رافد عيدان

Number Systems ,Base Conversions:-

- 1- Decimal Numbers.
- 2- Binary Numbers.
- 3- Octal Numbers.
- 4- Hexadecimal Numbers.

1. **Decimal Numbers:** - Decimal number system contains 10 digits: 0,1,2,3,4,5,6,7,8,9; and that is why its base is 10.
Decimal weight 10^4 10^3 10^2 10^1 10^0 . 10^{-1} 10^{-2} 10^{-3}

Example (1): $(345)_{10}$

$$300+40+5=10^2 * 3+10^1 * 4+10^0 * 5=345= (345)_{10}$$

$$\begin{array}{ccc} \downarrow & \downarrow & \downarrow \\ 3 & 4 & 5 \end{array}$$

Example (2): $(234)_{10}$

$$200+30+4=10^2 * 2+10^1 * 3+10^0 * 4=234= (234)_{10}$$

$$\begin{array}{ccc} \downarrow & \downarrow & \downarrow \\ 2 & 3 & 4 \end{array}$$

Example (3): $23.5 = (23.5)_{10}$

$$10^1 * 2 + 10^0 * 3 + 10^{-1} * 5 = 20+3+0.5=23.5$$

Where $10^0 = 1$

Example (4): $45.5 = (45.5)_{10}$

$$10^1 * 4 + 10^0 * 5 + 10^{-1} * 5 = 40+5+0.5=45.5$$

2. **Binary Numbers:**The binary number system its two digits a base-two system. The two binary digits (bits) are 1 and 0 (1, 0).

Binary weight : 2^3 2^2 2^1 2^0 2^{-1} 2^{-2} 2^{-3}

Weight value 8 4 2 1 . 0.5 0.25 0.125

A. Binary – to – Decimal Conversion:

*where $2^0 = 1$

Example (5): 1 1 0 1 1 0 1

1 1 0 1 1 0 1

$$\begin{aligned}
2^6 2^5 2^4 2^3 2^2 2^1 2^0 &= 2^6 * 1 + 2^5 * 1 + 2^4 * 0 + 2^3 * 1 + 2^2 * 1 + 2^1 * 0 + 2^0 * 1 \\
&= 64 * 1 + 32 * 1 + 16 * 0 + 8 * 1 + 4 * 1 + 2 * 0 + 1 * 1 \\
&= 64 + 32 + 0 + 8 + 4 + 0 + 1 \quad 109 \Rightarrow (109)_{10}
\end{aligned}$$

Example (6):

$$\begin{aligned}
10 \quad 0 \quad 1 \\
2^3 2^2 2^1 2^0 &= 2^3 * 1 + 2^2 * 0 + 2^1 * 0 + 2^0 * 1 \\
&= 8 * 1 + 4 * 0 + 2 * 0 + 1 * 1 \\
(9) &\Rightarrow (9)_{10} \quad 8 + 0 + 0 + 1
\end{aligned}$$

***The Fractional binary number 0.1011**

Example (7):

$$\begin{aligned}
0.1 \quad 0 \quad 1 \quad 1 \\
2^{-1} 2^{-2} 2^{-3} 2^{-4} &= 1 * 2^{-1} + 0 * 2^{-2} + 1 * 2^{-3} + 1 * 2^{-4} \\
&= 0.5 + 0 + 0.125 + 0.0625 \rightarrow (0.6875)_1
\end{aligned}$$

Example (8):

$$\begin{aligned}
0.1 \quad 1 \quad 0 \quad 0 \\
2^{-1} 2^{-2} 2^{-3} 2^{-4} &= 1 * 2^{-1} + 1 * 2^{-2} + 0 * 2^{-3} + 0 * 2^{-4} \\
&= 0.5 + 0.25 + 0 + 0 \rightarrow (0.75)_1
\end{aligned}$$

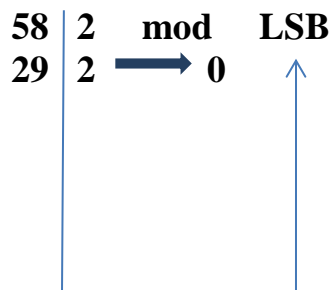
B. Decimal – to – Binary Conversion:

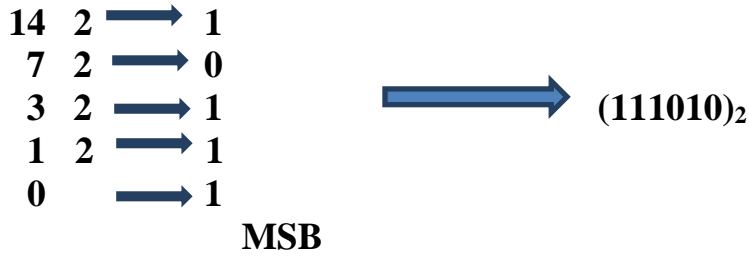
1- Convert a decimal number to binary using the repeated division - by-2. This method repeatedly divides a decimal number by 2 and records the quotient and remainder

2- Convert a decimal fraction to binary using the repeated Multiplication - by - 2 methods.

Example (9):

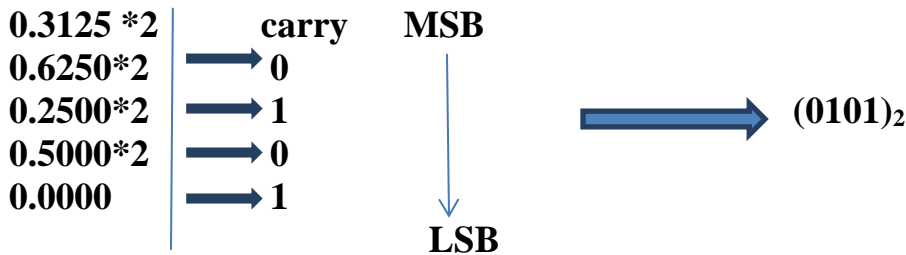
Number (58)₁₀ ===== (111010)₂





Example (10):

Number (0.3125)₁₀ ===== (0101)₂



3. **Octal Numbers:** The octal number system is composed of eight digits, which are 0, 1, 2, 3, 4, 5, 6, and 7.

To count above 7, begin another column and start over:

10, 11, 12, 13, 14, 15, 16, and 17.

20, 21, 22, 23, 24, 25, 26, and 27.

30, 31, 37.

Octal Weight 8³ 8² 8¹ 8⁰ .8⁻¹ 8⁻² 8⁻³

A. Octal – to – Decimal conversion:

Example (11):

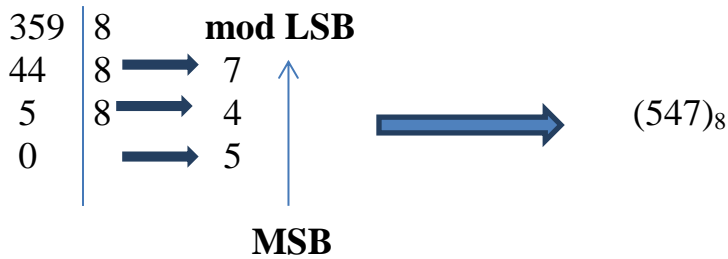
Octal number (2374)₈ ===== (1276)₁₀

$$\begin{aligned}
 (2374)_8 &= 8^3 * 2 + 8^2 * 3 + 8^1 * 7 + 8^0 * 4 \\
 &= 512 * 2 + 64 * 3 + 8 * 7 + 1 * 4 \\
 &= 1024 + 192 + 56 + 4 \\
 &= (1276)_{10}
 \end{aligned}$$

B. Decimal – to – Octal Conversion:

Example (12):

Decimal number $(359)_{10}$ ===== $(547)_8$



C. Octal – to – Binary Conversion:

Octal digit can be represented by a 3-bit binary number.

Octal digit binary

0 1 2 3 4 5 6 7

000 001 010 011 100 101 110 111

Example (13):

$(25)_8$ $(2 \ 5)_8$

$(010 \ 101)_2$

Example (14):

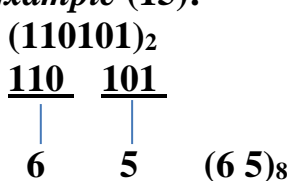
$(140)_8$ $(1 \ 4 \ 0)_8$

$(001100 \ 000)_2$

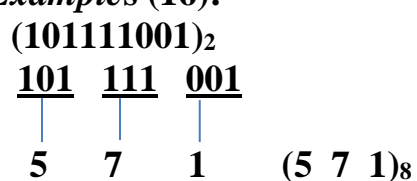
D. Binary – to – Octal Conversion:

Conversion binary number to octal number is start with right – most groups of three bits and moving from right to left.

Example (15):



Examples (16):



4.Hexadecimal Numbers: The hexadecimal number system has a base of sixteen; it is composed of 16 digits and alphabetic characters.

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