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Digital Electronics

PART 1

SIBIN K

Electrical Subject Matter Expert

Number systems

- Used to quantify the magnitude of something
- There are many number systems present
- Most frequently used number systems in the application of Digital computers are

a) Binary number system
b) Octal number system
c) Decimal number system
d) Hexadecimal number system

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Base (N) or radix (r) : number of different symbols used in that number system

Radix of *binary number system* is 2. we are using 2 different symbols only. They are 0 and 1.

Radix of *octal number system* is 8. we are using 8 different symbols only. They are 0,1,2,3,4,5,6 and 7.

Radix of *decimal number system* is 10. we are using 10 different symbols only. They are 0,1,2,3,4,5,6,7,8 and 9.

Radix of *hexadecimal number system* is 16. we are using 16 different symbols only. They are 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E and F.

Radix of *Ternary number system* is 3. we are using 3 different symbols only. They are 0,1 and 2.

To distinguish one number system from the other, the radix is used as suffix to that number.

10_2 binary number

10_8 octal number

10_{10} decimal number

10_{16} hexadecimal number

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- The base or radix is equal to the number of digits in the system
- The largest value of digit is one less than the radix
- Each digit is multiplied by the base raised to the appropriate power depending upon the digit position
- The number system in which the weight of each digit depends on its relative position within the number is called positional number system. So, binary, octal, decimal and hexadecimal number systems are called positional number systems.

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Decimal Numbers

- The position of each digit in a weighted number system is assigned a weight based on the base or radix of the system. The radix of decimal numbers is ten, because only ten symbols (0 through 9) are used to represent any number.

- The column weights of decimal numbers are powers of ten that increase from right to left beginning with $10^0 = 1$:

$$\ldots\ 10^5\ 10^4\ 10^3\ 10^2\ 10^1\ 10^0$$

- For fractional decimal numbers, the column weights are negative powers of ten that decrease from left to right:

$$\ldots\ 10^2\ 10^1\ 10^0\ .\ 10^{-1}\ 10^{-2}\ 10^{-3}\ 10^{-4}\ \ldots$$

- Decimal numbers can be expressed as the sum of the products of each digit times the column value for that digit.
- Thus, the number 5270 can be expressed as

$(5 \times 10^3) + (2 \times 10^2) + (7 \times 10^1) + (0 \times 10^0)$

Or

5x 1,000 + 2x 100 + 7 x 10 + 0 x 1

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Binary Numbers

- For digital systems, the binary number system is used. Binary has a radix of two and uses the digits 0 and 1 to represent quantities.

- The column weights of binary numbers are powers of two that increase from right to left beginning with $2^0 = 1$:

32 16 8 4 2 1

$$\ldots 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$$

- For fractional binary numbers, the column weights are negative powers of two that decrease from left to right:

$$2^{n-1} \ldots 2^2\ 2^1\ 2^0.\ 2^{-1}\ 2^{-2}\ 2^{-3}\ 2^{-4} \ldots 2^{n}$$

$\frac{1}{2}$ $\frac{1}{4}$ $\frac{1}{8}$ $\frac{1}{16}$

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Hexadecimal Numbers

- Hexadecimal uses sixteen characters to represent numbers: the numbers 0 through 9 and the alphabetic characters A through F.
- Counting in Hexadecimal:

  …, E, F, 10, 11, 12

Decimal	Hexadecimal	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	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

Octal Numbers

- Octal uses eight characters the numbers 0 to 7 to represent numbers. There is no 8 or 9 character in octal.

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

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Binary to Decimal Conversion

- Convert binary number 11001101 to its decimal equivalent

1 1 0 0 1 1 0 1

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- **Convert binary number 11001101.0110 to its decimal equivalent**

128	64	32	16	8	4	2	1	.	0.5	0.25	0.125	0.0625
1	1	0	0	1	1	0	1	.	0	1	1	0
									2^{-1}	2^{-2}	2^{-3}	2^{-4}

①

$\frac{1}{2}$

128 +
64
8
4
1
———
205

0.25
0.125
———
0.375

205.375

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Decimal to Binary Conversion

- Convert decimal number 25 to its binary equivalent
- Divide -by-two method or repetitive division

- Convert the decimal number 0.3125 to its corresponding binary
- Repetitive multiplication by 2 method

$0.3125 \times 2 = 0.625$

$0.625 \times 2 = 1.25$

$0.25 \times 2 = 0.5$

$0.5 \times 2 = 1.$

0.0101

0.0101

0.1010

0.111

↓

0.5 0.25 0.125

$0.25 + \leftarrow 2^{-2}$

$0.0625 \leftarrow 2^{-3}$

2^{-4}

0.3125

- Answer : 0.0101

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Octal to Decimal Conversion

Convert octal number 5726 to its decimal equivalent

$$= 5 \times 8^3 + 7 \times 8^2 + 2 \times 8^1 + 6 \times 8^0$$

$$= 5 \times 512 + 7 \times 64 + 2 \times 8 + 6$$

$$= 2560 + 448 + 16 + 6$$

$$= 3030$$

Convert octal number 0.45 to its decimal equivalent

0.4 5 (8)

8^{-1} 8^{-2}

$\frac{1}{8}$ $\frac{1}{64}$

$= 4x\ 8^{-1} + 5x\ 8^{-2}$

$= 4x\ 0.125 + 5x\ 0.15625$

$= 0.5 + 0.078125$

$= 0.578125$

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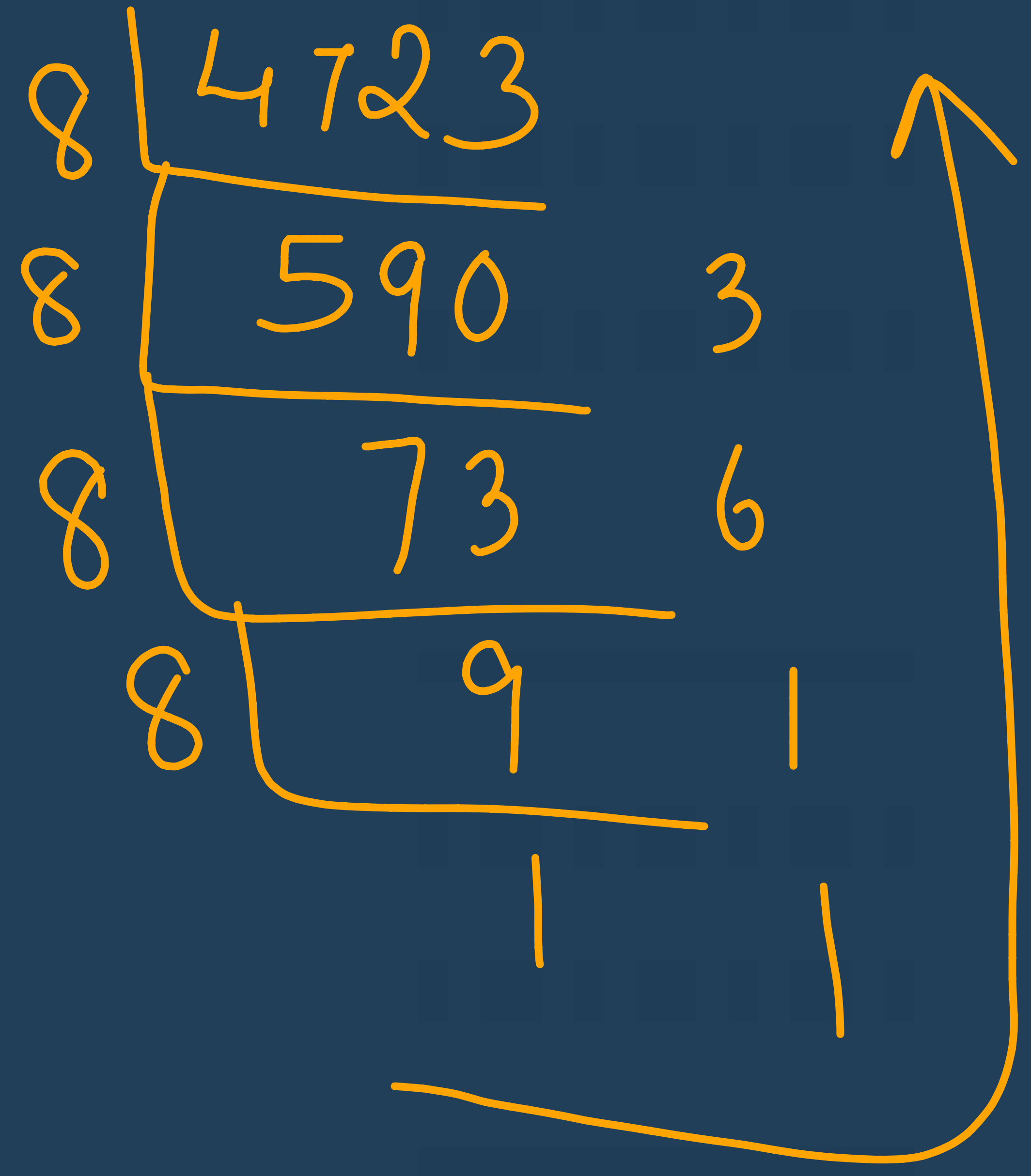
Decimal to Octal Conversion

Convert decimal number 4723 to its octal equivalent

Repeated division by 8



Answer : 11163

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Hexadecimal to decimal conversion

- Covert the hexadecimal 45AC to decimal equivalent

$= 4x\ 16^3 + 5x\ 16^2 + Ax\ 16^1 + Cx\ 16^0$

$= 4x4096 + 5x256 + 10x16 + 12x\ 1$

$= 17836$

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Decimal to Hexadecimal conversion

Covert the decimal 35 to hexadecimal equivalent

By repeated division by 16 ✓

$$16 \,|\, 35$$
$$16 \,|\, 2 \quad 3$$
$$0 \quad 2$$

$$23_{(16)}$$

$$2 \times 16^1 + 3 \times 16^0$$

$$32 + 3 = 35$$

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Which of the following represents the decimal form of binary 0.0111

2^{-1} 2^{-2} 2^{-3} 2^{-4}

0.5 0.25 0.125 0.0625

0.25
0.125
0.0625
.4375

- 0.1600
- 0.22728
- 0.4375 ✓
- 0.7964

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Decimal 17 in octal system is represented

888	111
21	27

A nibble is equal to ----- bit(s)

4 bit → nibble
8 bit → byte

1

2

4 ✓

8

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The hexadecimal number A0 has the decimal value

$A \times 16^1 + 0 \times 16^0$

$10 \times 16 + 0 \times 1$

160

- 80
- 256
- 100
- 160 ✓

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THANK YOU ☺