University of Al-Mustaqbal
College of Science
Department of Medical Physics

Digital Electronic

Third stage

System Numbers

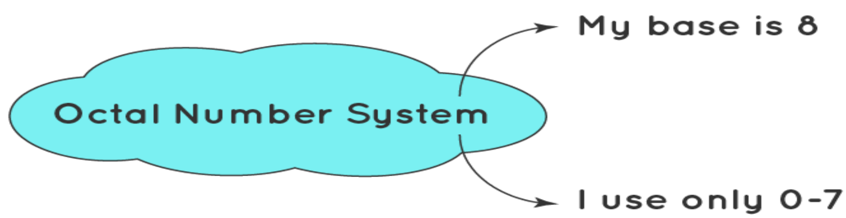
Lecture Two

Name of lecturer

Asst .prof .Dr Rusul Abdul Ameer

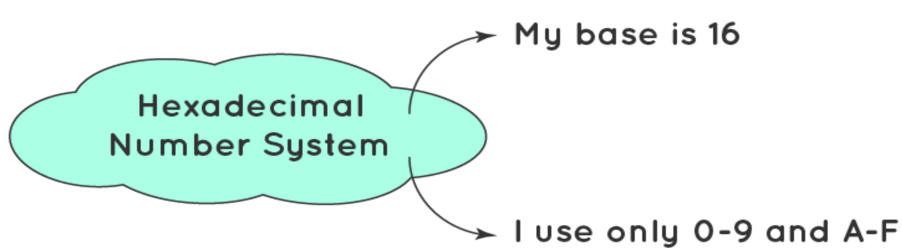
Octal Number System

The octal number system uses eight digits: 0,1,2,3,4,5,6 and 7 with the base of 8. The advantage of this system is that it has lesser digits when compared to several other systems, hence, there would be fewer computational errors. Digits like 8 and 9 are not included in the octal number system. Just like the binary, the octal number system is used in minicomputers but with digits from 0 to 7. For example, 35_8, 23_8, and 141_8 are some examples of numbers in the octal number system.



Hexadecimal Number System

The hexadecimal number system uses sixteen digits/alphabets: 0,1,2,3,4,5,6,7,8,9 and A,B,C,D,E,F with the base number as 16. Here, A-F of the hexadecimal system means the numbers 10-15 of the decimal number system respectively. This system is used in computers to reduce the large-sized strings of the binary system. For example, $7B3_{16}$, $6F_{16}$, and $4B2A_{16}$ are some examples of numbers in the hexadecimal number system.



Conversion of Number Systems

A number can be converted from one number system to another number system using number system formulas. Like binary numbers can be converted to octal numbers and vice versa, octal numbers can be converted to decimal numbers and vice versa, and so on. Let us see the steps required in converting number systems.

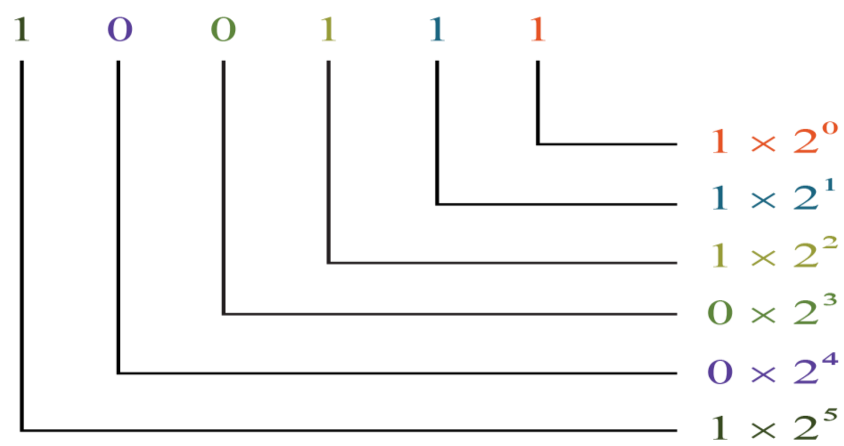
1-Steps for Conversion of Binary to Decimal Number System

Example: **Convert $(100111)_2$ into the decimal system.**

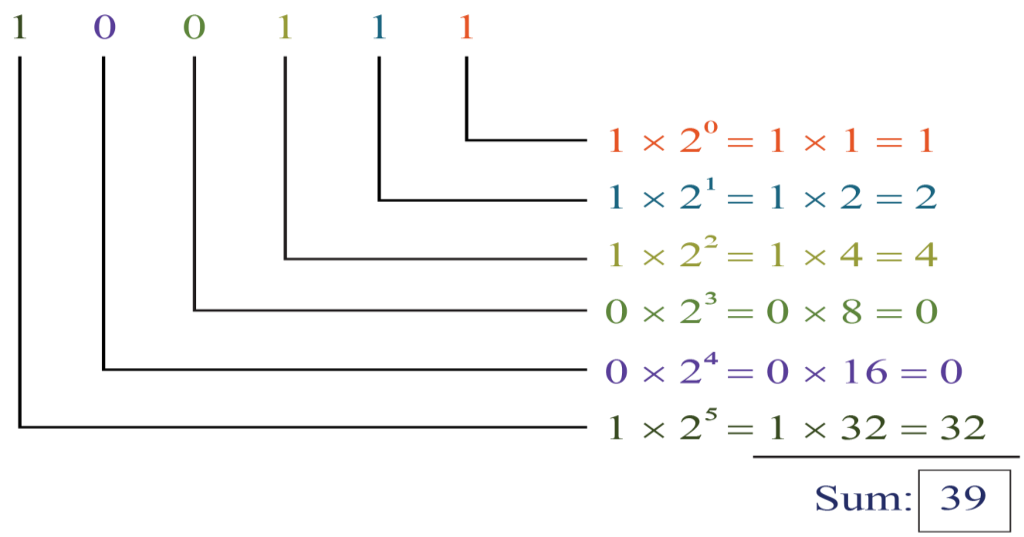
Solution:

Step 1: Identify the base of the given number. Here, the base of 100111_2 is 2.

Step 2: Multiply each digit of the given number, starting from the rightmost digit, with the exponents of the base. The exponents should start with 0 and increase by 1 every time as we move from right to left. Since the base is 2 here, we multiply the digits of the given number by 2^0, 2^1, 2^2 , and so on from right to left.



Step 3: We just simplify each of the above products and add them.



Here, the sum is the equivalent number in the decimal number system of the given number. Or, we can use the following steps to make this process simplified.

$(100111)_2 = (1 \times 2^5) + (0 \times 2^4) + (0 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (1 \times 2^0)$

$= (1 \times 32) + (0 \times 16) + (0 \times 8) + (1 \times 4) + (1 \times 2) + (1 \times 1)$

$= 32 + 0 + 0 + 4 + 2 + 1 \quad = 39$ Thus, $100111_2 = 39_{10}$.

2-Conversion of Decimal Number System to Binary / Octal / Hexadecimal Number System

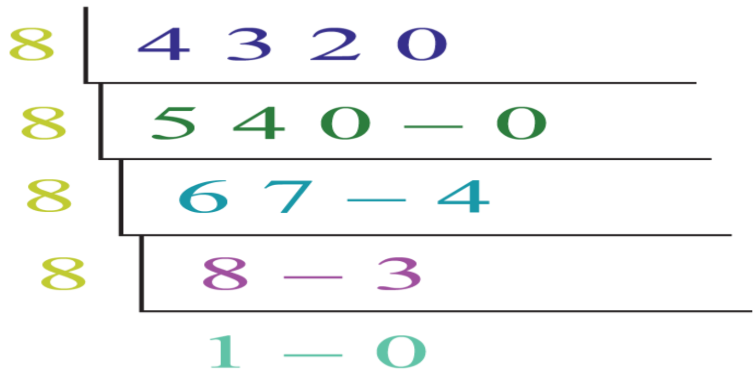
To convert a number from the decimal number system to a binary/octal/hexadecimal number system, we use the following steps. The steps are shown on how to convert a number from the decimal system to the octal system.

Example: **Convert 4320_{10} into the octal system.**

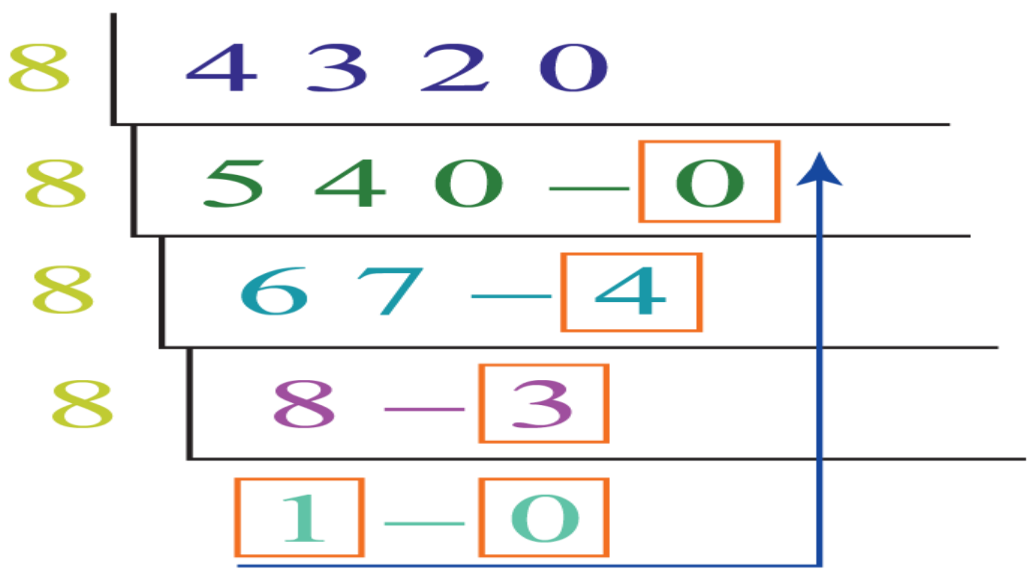
Solution:

Step 1: Identify the base of the required number. Since we have to convert the given number into the octal system, the base of the required number is 8.

Step 2: Divide the given number by the base of the required number and note down the quotient and the remainder in the quotient-remainder form. Repeat this process (dividing the quotient again by the base) until we get the quotient less than the base.



Step 3: The given number in the octal number system is obtained just by reading all the remainders and the last quotient from bottom to top.



Therefore, $4320_{10} = 10340_{8}$

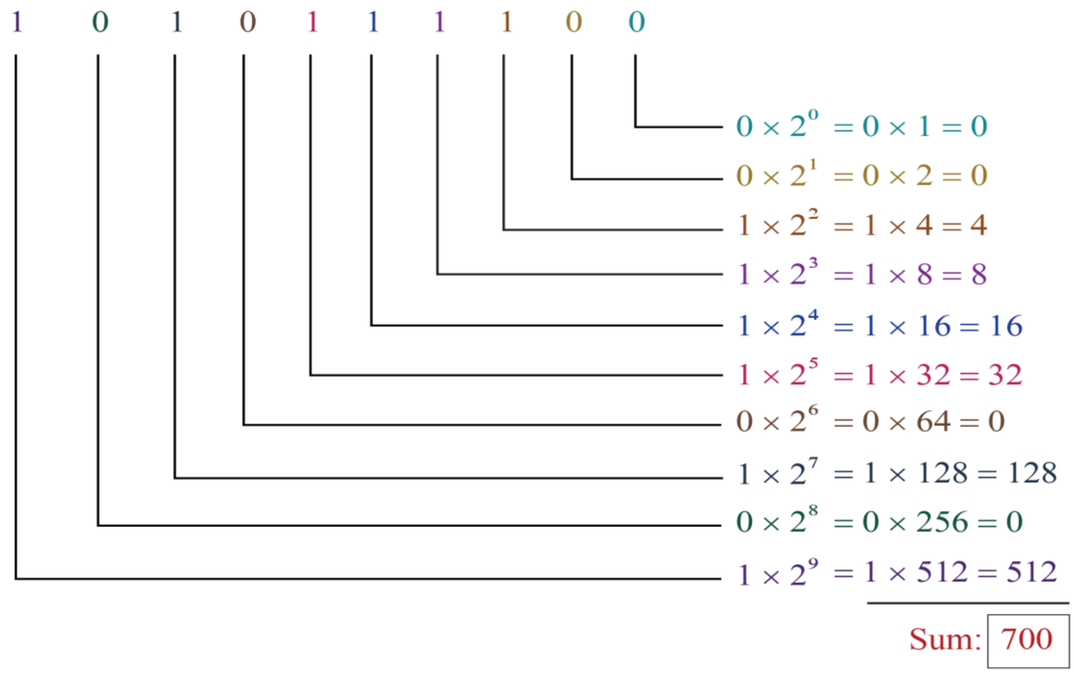
3-Conversion from One Number System to Another Number System

To convert a number from one of the binary/octal/hexadecimal systems to one of the other systems, we first convert it into the decimal system, and then we convert it to the required systems by using the above-mentioned processes.

Example: **Convert $(1010111100)_2$ to the hexadecimal system.**

Solution:

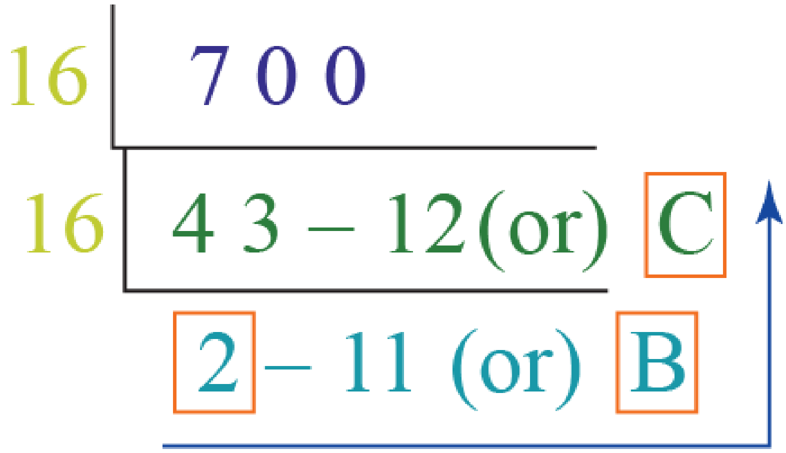
Step 1: Convert this number to the decimal number system as explained in the above process.



Thus, $1010111100_2 = 700_{10} \rightarrow (1)$

Step 2: Convert the above number (which is in the decimal system), into the required number system (hexadecimal).

Here, we have to convert 700_{10} into the hexadecimal system using the above-mentioned process. It should be noted that in the hexadecimal system, the numbers 11 and 12 are written as B and C respectively.



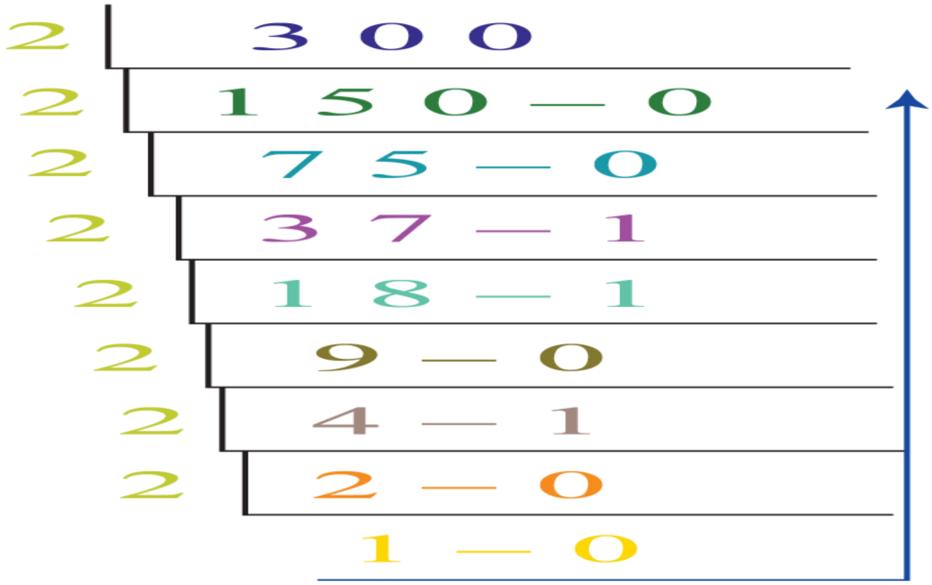
Thus, $700_{10} = 2BC_{16} \rightarrow (2)$

From the equations (1) and (2), $1010111100_2 = 2BC_{16}$

Number Systems Examples

- Example 1: **Convert (300_{10}) into the binary number system .**

Solution: 300_{10} is in the decimal system. We divide 300 by 2 and note down the quotient and the remainder. We will repeat this process for every quotient until we get a quotient that is less than 2.

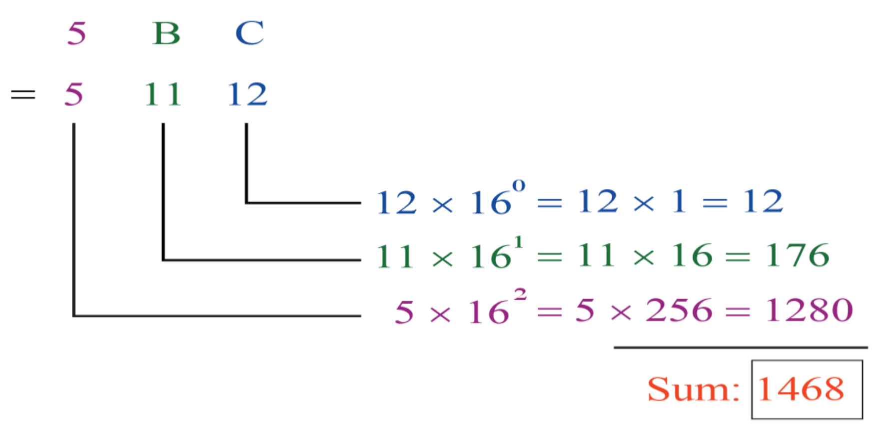


The equivalent number in the binary system is obtained by reading all the remainders and just the last quotient from bottom to top as shown above.

Thus, $300_{10} = 100101100_2$

- Example 2: **Convert ($5BC_{16}$) into the decimal system.**

Solution: $5BC_{16}$ is in the hexadecimal system. We know that B = 11 and C = 12 in the hexadecimal system. So we get the equivalent number in the decimal system using the following process:



Thus, $5BC_{16} = 1468_{10}$

- Example 3: **Convert (144_8) into the hexadecimal system.**

Solution: The base of 144_8 is 8. First, we will convert this number into the decimal system as follows:

1 4 4

$$4 \times 8^0 = 4 \times 1 = 4$$
$$4 \times 8^1 = 4 \times 8 = 32$$
$$1 \times 8^2 = 1 \times 64 = 64$$

100

Thus, $144_8 = 100_{10} \rightarrow (1)$. Now we will convert this into the hexadecimal system as follows:

16 | 1 0 0

6 – 4

Thus, $100_{10} = 64_{16} \rightarrow (2)$

From the equations (1) and (2), we can conclude that: $144_8 = 64_{16}$

Example 4:Convert $(1579)_{16}$ to the decimal number.

Solution: Given $(2579)_{16}$ is a hexadecimal number.

For converting the hexadecimal number to the corresponding decimal number:

$= 2 \times 16^3 + 5 \times 16^2 + 7 \times 16^1 + 6 \times 16^0$

$= 8192 + 1280 + 112 + 6$

$= (9590)_{10}$

Example 5: Convert 10111 into the decimal system.

Solution: Given, $(10111)_2$ is a binary number.

Multiplying each digit of the given number, starting from the right, with the exponents of the base and adding the results, we get:

$= (1 \times 2^4) + (0 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (1 \times 2^0)$

$= 16 + 8 + 4 + 1$

$= 29$

Thus, $(10111)_2 = (29)_{10}$