Conversion from a Binary to Octal Number and Vice Versa

We know that the maximum digit in an octal number system is 7, which can be represented as 111_2 in a binary system. Hence, starting from the LSB, we group three digits at a time and replace them by the decimal equivalent of those groups and we get the final octal number.

Example 1.11. Convert 101101010_2 into an equivalent octal number.

Solution. The binary number given is 101101010

Starting with LSB and grouping 3 bits 101 101 010

Octal equivalent 5 5 2

Hence the octal equivalent number is $(552)_8$.

Example 1.12. Convert 1011110_2 into an equivalent octal number.

Solution. The binary number given is 1011110

Starting with LSB and grouping 3 bits 001 011 110

Octal equivalent 1 3 6

Hence the octal equivalent number is $(136)_8$.

Since at the time of grouping the three digits in Example 1.14 starting from the LSB, we find that the third group cannot be completed, since only one 1 is left out in the third group, so we complete the group by adding two 0s in the MSB side. This is called left padding of the number with 0. Now if the number has a fractional part then there will be two different classes of groups—one for the integer part starting from the left of the decimal point and proceeding toward the left and the second one starting from the right of the decimal point and proceeding toward the right. If, for the second class, any 1 is left out, we complete the group by adding two 0s on the right side. This is called right-padding.

Example 1.13. Convert 1101.0111_2 into an equivalent octal number.

Solution. The binary number given is 1101.0111

Grouping 3 bits 001 101. 011 100

Octal equivalent: 1 5 3 4

Hence the octal number is $(15.34)_8$.

Now if the octal number is given and you're asked to convert it into its binary equivalent, then each octal digit is converted into a 3-bit-equivalent binary number and combining all those digits we get the final binary equivalent.

Example 1.14. Convert 235_8 into an equivalent binary number.

Solution. The octal number given is 2 3 5

3-bit binary equivalent 010 011 101

Hence the binary number is $(010011101)_2$.

Example 1.15. Convert 47.321_8 into an equivalent binary number.

Solution. The octal number given is 4 7 3 2 1

3-bit binary equivalent   100 111 011 010 001

Hence the binary number is $(100111.011010001)_2$.

Conversion from a Binary to Hexadecimal Number and Vice Versa

We know that the maximum digit in a hexadecimal system is 15, which can be represented by 1111_2 in a binary system. Hence, starting from the LSB, we group four digits at a time and replace them with the hexadecimal equivalent of those groups and we get the final hexadecimal number.

Example 1.16. Convert 11010110_2 into an equivalent hexadecimal number.

Solution. The binary number given is 11010110

Starting with LSB and grouping 4 bits 1101 0110

Hexadecimal equivalent D 6

Hence the hexadecimal equivalent number is $(D6)_{16}$.

Example 1.17. Convert 110011110_2 into an equivalent hexadecimal number.

Solution. The binary number given is 110011110

Starting with LSB and grouping 4 bits 0001 1001 1110

Hexadecimal equivalent   1   9   E

Hence the hexadecimal equivalent number is $(19E)_{16}$.

Since at the time of grouping of four digits starting from the LSB, in Example 1.19 we find that the third group cannot be completed, since only one 1 is left out, so we complete the group by adding three 0s to the MSB side. Now if the number has a fractional part, as in the case of octal numbers, then there will be two different classes of groups—one for the integer part starting from the left of the decimal point and proceeding toward the left and the second one starting from the right of the decimal point and proceeding toward the right. If, for the second class, any uncompleted group is left out, we complete the group by adding 0s on the right side.

Example 1.18. Convert 111011.011_2 into an equivalent hexadecimal number.

Solution. The binary number given is 111011.011

Grouping 4 bits   0011 1011. 0110

Hexadecimal equivalent   3   B   6

Hence the hexadecimal equivalent number is $(3B.6)_{16}$.

Now if the hexadecimal number is given and you're asked to convert it into its binary equivalent, then each hexadecimal digit is converted into a 4-bit-equivalent binary number and by combining all those digits we get the final binary equivalent.

Example 1.19. *Convert $29C_{16}$ into an equivalent binary number.*

Solution. The hexadecimal number given is 2 9 C

4-bit binary equivalent 0010 1001 1100
Hence the equivalent binary number is $(001010011100)_2$.

Example 1.20. *Convert $9E.AF2_{16}$ into an equivalent binary number.*

Solution. The hexadecimal number given is 9 E A F 2
4-bit binary equivalent 1001 1110 1010 1111 0010
Hence the equivalent binary number is $(10011110.101011110010)_2$.

Conversion from an Octal to Hexadecimal Number and Vice Versa

Conversion from octal to hexadecimal and vice versa is sometimes required. To convert an octal number into a hexadecimal number the following steps are to be followed:
(*i*) First convert the octal number to its binary equivalent (as already discussed above).
(*ii*) Then form groups of 4 bits, starting from the LSB.
(*iii*) Then write the equivalent hexadecimal number for each group of 4 bits.

Similarly, for converting a hexadecimal number into an octal number the following steps are to be followed:
(*i*) First convert the hexadecimal number to its binary equivalent.
(*ii*) Then form groups of 3 bits, starting from the LSB.
(*iii*) Then write the equivalent octal number for each group of 3 bits.

Example 1.21. Convert the following hexadecimal numbers into equivalent octal numbers.

(a) A72E *(b) 4.BF85*

Solution:

(*a*) Given hexadecimal number is A 7 2 E
Binary equivalent is 1010 0111 0010 1110
= 1010011100101110
Forming groups of 3 bits from the LSB 001 010 011 100 101 110
Octal equivalent 1 2 3 4 5 6
Hence the octal equivalent of $(A72E)_{16}$ is $(123456)_8$.

(*b*) Given hexadecimal number is 4 B F 8 5
Binary equivalent is 0100 1011 1111 1000 0101
= 0100.1011111110000101
Forming groups of 3 bits 100. 101 111 111 000 010 100
Octal equivalent 4 5 7 7 0 2 4
Hence the octal equivalent of $(4.BF85)_{16}$ is $(4.577024)_8$.

Example 1.22. Convert $(247)_8$ into an equivalent hexadecimal number.

Solution. Given octal number is 2 4 7

Binary equivalent is 010 100 111

= 010100111

Forming groups of 4 bits from the LSB 1010 0111

Hexadecimal equivalent A 7

Hence the hexadecimal equivalent of $(247)_8$ is $(A7)_{16}$.

Example 1.23. Convert $(36.532)_8$ into an equivalent hexadecimal number.

Solution. Given octal number is 3 6 5 3 2

Binary equivalent is 011 110 101 011 010

=011110.101011010

Forming groups of 4 bits 0001 1110. 1010 1101

Hexadecimal equivalent 1 E. A D

Hence the hexadecimal equivalent of $(36.532)_8$ is $(1E.AD)_{16}$.