Paper 7, TDC Part-3
Chapter– 3, Number Systems and Codes
Electronics
Octal Number System

By:

Mayank Mausam

Assistant Professor (Guest Faculty)

Department of Electronics

L.S. College, BRA Bihar University,

Muzaffarpur, Bihar

<u>Octal Number System</u>

As clear from the name, the octal number system uses eight digits/symbols- 0,1,2,3,4,5,6 and 7 to represent numbers. So the number system with eight as radix/base is Octal Number System.

It is also a positional system and may has two parts: integer and fractional, set apart by radix point.

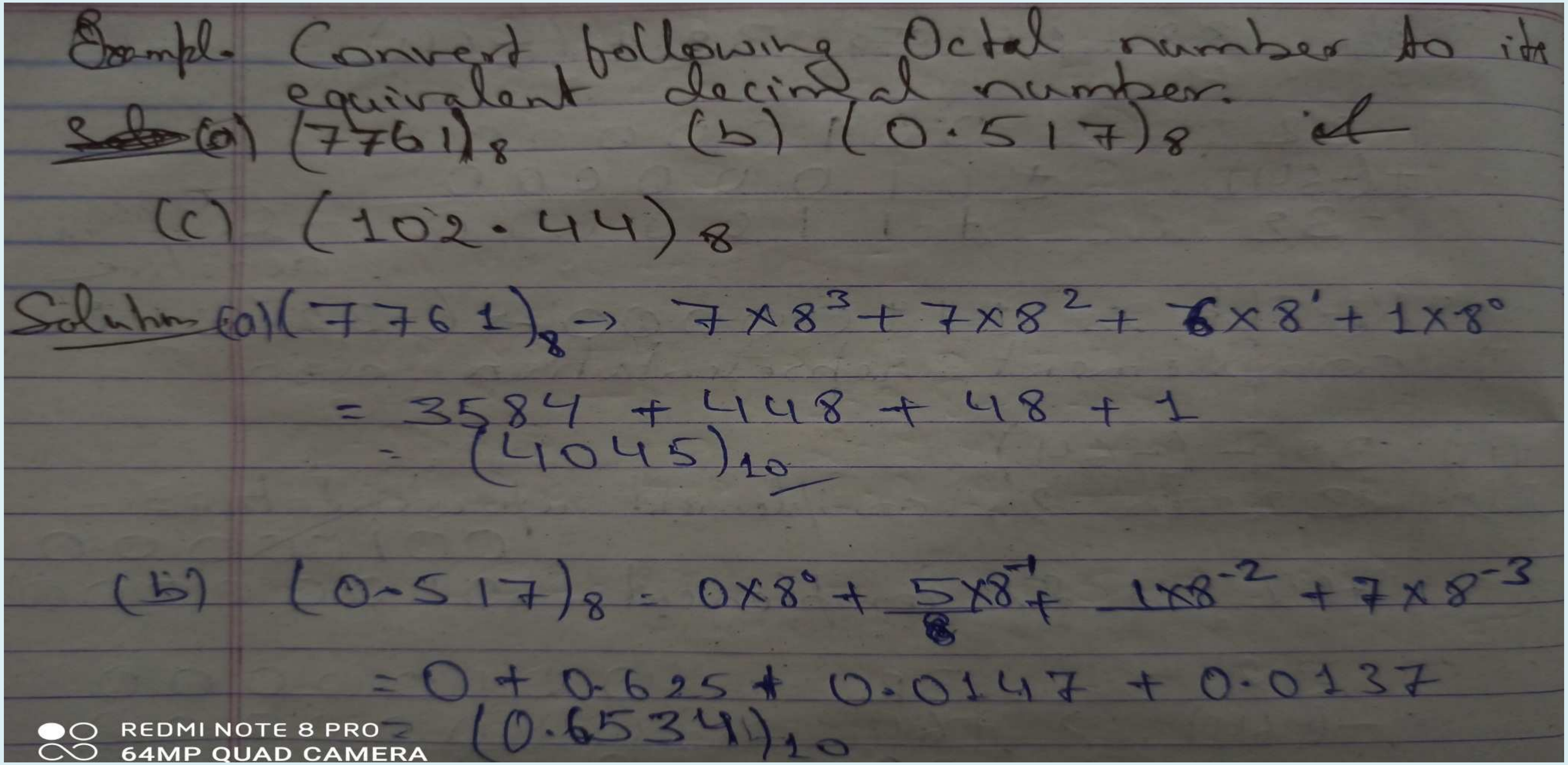
Example:- $(1732.505)_8$, $(776.21)_8$, $(6617)_8$, $(0.207)_8$ etc

<u>Conversion of Octal number system into other number system</u>

- **<u>Octal-to-Decimal:-</u>**

Number Systems and Codes

Octal number can be converted into its equivalent decimal number using weights assigned to each octal digit position.



Example- Convert following Octal number to its equivalent decimal number.

(a) $(7761)_8$ (b) $(0.517)_8$

(c) $(102.44)_8$

Solution (a) $(7761)_8 \rightarrow 7\times8^3 + 7\times8^2 + 6\times8^1 + 1\times8^0$

$= 3584 + 448 + 48 + 1$

$= (4045)_{10}$

(b) $(0.517)_8 = 0\times8^0 + 5\times8^{-1} + 1\times8^{-2} + 7\times8^{-3}$

$= 0 + 0.625 + 0.0147 + 0.0137$

$= (0.6534)_{10}$

Number Systems and Codes

Example. Convert following Octal number to its equivalent decimal number.

(a) $(7761)_8$ (b) $(0.517)_8$

(c) $(102.44)_8$

Solution (a) $(7761)_8 \rightarrow 7 \times 8^3 + 7 \times 8^2 + 6 \times 8^1 + 1 \times 8^0$

$= 3584 + 448 + 48 + 1$

$= (4045)_{10}$

(b) $(0.517)_8 = 0 \times 8^0 + 5 \times 8^{-1} + 1 \times 8^{-2} + 7 \times 8^{-3}$

$= 0 + 0.625 + 0.0147 + 0.0137$

$= (0.6534)_{10}$

Number Systems and Codes

(b) $(0.517)_8 = 0 \times 8^0 + 5 \times 8^{-1} + 1 \times 8^{-2} + 7 \times 8^{-3}$

$= 0 + 0.625 + 0.0147 + 0.0137$

$= (0.6534)_{10}$

(c) $(102.44)_8 = 1 \times 8^2 + 0 \times 8^1 + 2 \times 8^0 + 4 \times 8^{-1} + 4 \times 8^{-2}$

$= 64 + 0 + 2 + 0.5 + 0.0625 = (66.5625)_{10}$

Decimal-to-Octal Conversion:-

The procedure for conversion of decimal number is same as that of binary to decimal. Here 8 is used in place of 2 for division.

Number Systems and Codes

Q1) Convert following ~~Octal~~ decimal number to Octal number. Upto four digit after decimal

(a) $(903)_{10}$ (b) $(0.715)_{10}$

(c) $(133.27)_{10}$

Solution:

		Remainder	
8	903		
8	112	7	→ LSB
8	14	0	
8	1	6	
	0	1	→ MSB

So, $(903)_{10} = (1607)_8$

(b) $(0.715)_{10} = (?)_8$ Upto 4 digit

Number Systems and Codes

(b) $(0.715)_{10} = (\,?\,)_8$ Upto 4 digit

$0.715 \times 8 = 5.720 \rightarrow 5$

$0.72 \times 8 = 5.66 \rightarrow 5$

$0.66 \times 8 = 5.28 \rightarrow 5$

$0.28 \times 8 = 2.24 \rightarrow 2$

$(0.715)_{10} = (0.5552)_8$

(C) To find octal equivalent of $(133.27)_{10}$ we seperatly find octal equivalent of Integer part first i.e. 133 the we find the octal equivalent of fractional part i.e. '.27'.

Number Systems and Codes

		Remainder	
8	133		
8	16 →	5	→ LSB
8	2 →	0	
	0 →	2	→ MSB

Now decimal part,

$0.27 \times 8 \rightarrow 2.16 \rightarrow 2$

$0.16 \times 8 \rightarrow 1.28 \rightarrow 1$

$0.28 \times 8 \rightarrow 2.24 \rightarrow 2$

$0.24 \times 8 \rightarrow 1.92 \rightarrow 1$

So, $(133.27)_{10} = (205.2121)_8$

Number Systems and Codes

Octal-To-Binary Number :-

A octal number can be converted to it's equivalent binary number by replacing each octal digit by 3-bit equivalent binary number. Table below gives the binary equivalent of 0 - 7 octal symbol/digit.

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

Number Systems and Codes

Soln: (a) $(700)_8 = (\overbrace{111}^{7}\ \overbrace{000}^{0}\ \overbrace{000}^{0})_2$

(b) $(5142)_8 = (\overbrace{101}^{5}\ \overbrace{001}^{1}\ \overbrace{100}^{4}\ \overbrace{010}^{2})_2$

Example: Convert following Octal numbers to it equivalent binary number

(a) $(0.712)_8$ (b) $(63.02)_8$

Soln: (a) $(0.712)_8 =$ ~~(0.00~~ $(0.\overbrace{111}^{7}\ \overbrace{001}^{1}\ \overbrace{010}^{2})_2$

(b) $(63.02)_8 = (110\ 011.000\ 010)_2$

Number Systems and Codes

Let's verify the process with the help of conversion ~~to~~ into Decimal system.

Binary equivalent of $(56)_8 = (101\,110)_2$

Decimal equivalent of $(56)_8 = (5 \times 8^1 + 6 \times 8^0)_{10}$

$= (40 + 6)_{10} = (46)_{10}$

Decimal equivalent of $(101110)_2 =$

$= (1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0)_{10}$

$= (32 + 0 + 8 + 4 + 2 + 0)_{10}$

$= (46)_{10}$

So, $(56)_8 = (101\,110)_2 = (46)_{10}$

So we while converting Octal to binary we replace each Octal digit by equivalent 3-bit binary number.

Number Systems and Codes

Binary-to-Octal Number System :-

Binary numbers can be converted into equivalent octal number by making ~~of 3~~ ~~bits~~ groups of three bits. For integer part grouping of bits is done from LSB to MSB while for fractional part, the grouping of bits are done from ~~they~~ the binary point. Then replace each group of 3 bits by it's equivalent Octal symbol/digit.

Example Convert following Binary Numbers to its equivalent Octal Numbers.

(a) 110101100 (b) 1001101

(c) 0.110111011 (d) 0.11011

(d) 11011.0101

Solution (a) $(110\ 101\ 100)_2 = (654)_8$ ← Direction of grouping

MSB → 6, 5, 4 ← LSB

(b) $(1\ 001\ 101)_2$ =

→ 1, 5

Here after grouping we are left with one

Number Systems and Codes

bit for which there is no more bits to make group. So here we add 2 zero ('0') towards MSB to make grouping. By adding zeros the value of number will remain unchanged.,

So after two zeros,

$(\overline{001}\ \overline{001}\ \overline{101})_2 = (115)_8$

↓1 ↓1 ↓5

In case of fractional part zeros are added towards right to form the group. Then again the number will remain unchanged. This can be seen in example discussed later.

→ Direction for grouping

(c) $(0.\overline{110}\ \overline{111}\ \overline{011})_2 \rightarrow (0.673)_8$

(d) $(0.\overline{110}\ 11)_2$ here one more bit is required to make group so we add ~~zero~~ required number of zero to the number to make group. So number after adding zero.

bit for which there is no more bits to make group. So here we add 2 zero ('0') towards MSB to make grouping. By adding zeros the value of number will remained unchanged.,
So after two zeros,

$(001\ 001\ 101)_2 = (115)_8$

In case of fractional part zeros are added towards right to form the group. Then again the number will remain unchanged. This can be seen in example discussed later.

Direction for grouping →

(c) $(0.110\ 111\ 011)_2 \rightarrow (0.673)_8$

(d) $(0.110\ 11)_2$ here one more bit is required to make group so we add ~~zero~~ required number of zero to the number to make group. So number after adding zero.

Number Systems and Codes

$(0.110\,110)_2 = (0.66)_8$

(d) $(11011.0101)_2 \Rightarrow$

After adding required zero to integer part and fractional part.

$(011\,011.010\,100)_2 = (33.24)_8$

Thank You