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Unit- 1

1. Number Systems and Codes:

In binary systems the data is presented in the binary states. So the used data does not prevent errors due to noise and any other interfering signals.

Number System:

The decimal number system (0,1,2,...9) is used eventhough and its also has some other system like binary, octal and hexadecimal etc.

The data can be expressed as:

$$a_m(x)^{m-1} + a_{m-1}(x)^{m-2} + \ldots + a_2x^1 + a_1x^0 + b_1(x)^{-1} + b_2(x)^{-2} + \ldots + b_n(x)^{-n}$$

Binary Numbers It consist with only two digit 0 and 1. its ten digits is a base ten system. The position of the number. in the binary system indicate the weight within the no. As the weight inch by higher position than the power incresing on 2.

for Ex: $(198)_{10} = 1 \times 10^2 + 9 \times 10^1 + 8 \times 10^0$

Hundred — tens — ones

it can also be presented by positional weight.

$(198)_{10} = (11000110)_2$

$= 1\times2^7 + 1\times2^6 + 0\times2^5 + 0\times2^4 + 0\times2^3 + 1\times2^2 + 1\times2^1 + 0\times2^0$

$= 128 + 64 + 0 + 0 + 0 + 4 + 2 + 0$

$= 198$

Conversion of Binary to Decimal

Ex $(101111.1101)_2$

Ans – A no can be changed by multiply a binary no 1 or 0 by their weight and adding the product term. The decimal sides part can solve separately.

101111

$1\times2^0 = 1$

$1\times2^1 = 2$

$1\times2^2 = 4$

$1\times2^3 = 8$

$0\times2^4 = 0$

$1\times2^5 = 32$

47

$(101111)_2$ can be written as $(47)_{10}$

0.1101

$1\times2^{-4} = .0625$

$0\times2^{-3} = 0.000$

$1\times2^{-2} = 0.2500$

$1\times2^{-1} = 0.5000$

0.8125

Thus $(0.1101)_2$ is equal to $(0.8125)_{10}$

So the $(101111.1101)_2 = (47.8125)_{10}$

Conversion of decimal number to binary number

A decimal number is changed into a binary number by dividing the decimal no by 2 and the division is continued until 0 has obtained. The binary no ~~taken~~ is obtained by taking the remainder after each division in the reverse order.

Example

$$(53.625)_{10} = (\ )_2$$

Integer Conversion

Division		Remainder
2	53	1
2	26	0
2	13	1
2	6	0
2	3	1
2	1	1
	0	

Reading the remainder from bottom to top

$$(53)_{10} = (110101)_2$$

Fractional Conversion

The binary no ~~of~~ fractional part can be taken by multiplying the number continuosly by 2.

multiplication	integer
$0.625 \times 2 = 1.25$	1
$0.250 \times 2 = 0.50$	0
$0.500 \times 2 = 1.00$	1
$0.00 \times 2 = 0.00$	0

Thus the equalent of the fractional part

$$(0.625)_{10} = (0.101)_2$$

So the equalent no

$$\boxed{(53.625)_{10} = (110101.101)_2}$$

The conversion is done under 3 steps

step 1 The integer part changing done by getting the remainder from the particular number

step 2 The fractional conversion is obtained by multiplying the number continuosly by 2 and record a carry in the integer position each time.

Advantage of Binary number.

→ It has a clear edge over number system for use in the computer system.

→ All types of data can be represented in the form of 0's and 1's.

→ Basic device used for H/W implementation would be operated in two different mode.

→ for ex: A BJT can be operated in ON/OFF mode.

Examples of Conversion:

(i) $(1001.0101)_2$

Sol The integer part 1001

decimal equalent $= 1\times2^0 + 0\times2^1 + 0\times2^2 + 1\times2^3$

$= 1+0+0+8 = 9$

for fractional part $(.0101)$

decimal equalent $= 0\times2^{-1} + 1\times2^{-2} + 0\times2^{-3} + 1\times2^{-4}$

$= 0 + 0.25 + 0 + 0.0625$

$= 0.3125$

Thus $(1001.0101)_2 = 9.3125$

2 Octal numbers — The number system uses the digit 0, 1, 2, 3, 4, 5, 6, 7. The base of this system is 8. Each represented digit has a weight. The octal equalent can be found by dividing a given number by 8, until a quotient of 0 is obtained.

Conversion of Decimal to octal no.

(i) $(444.456)_{10}$

Division		Remainder
8	444	4
8	55	7
8	6	6
	0	

The remainder will be measured by bottom to top. $(444)_{10} = (674)_8$

Fractional Conversion.

multiplication		Generated integer
0.456 x 8	= 3.648	3
0.648 x 8	= 5.184	5
0.184 x 8	= 1.472	1
0.472 x 8	= 3.776	3
0.776 x 8	= 6.208	6

Thus the octal equalent is

$(444.456)_{10} \longrightarrow (674.35136)_8$

Conversion the octal to decimal number

(a) $(237)_8$

$(237)_8 = 2\times8^2 + 3\times8^1 + 7\times8^0$

$= 2\times64 + 3\times8 + 7\times1$

$= 128 + 24 + 7$

$\boxed{(237)_8 = (159)_{10}}$

b) $(120)_8 = 1\times8^2 + 2\times8^1 + 0\times8^0$

$= 1\times64 + 2\times8 + 0\times1$

$= 64 + 16 + 0$

$\boxed{(120)_8 = (80)_{10}}$

(c) $(46.26)_8 = (\ )_{10}$

Conversion of 46 into decimal

$(46)_8 = 6\times8^0 + 4\times8^1$

$= 6 + 32$

$= 38$

$.26 = 2\times8^{-1} + 6\times8^{-2}$

$= 2\times.125 + 6\times0.015$

$= .25 + 0.093 = 0.343$

Thus the Conversion of

$$\boxed{(46.26)_8 = (38.343)_{10}}$$

Octal to binary Conversion / Binary to Octal Conversion

for Converting Octal to binary and binary to octal each digit would be replaced by its 3 digit equalent.

$(376)_8$ = 3 7 6
011 111 110

$$\boxed{(376)_8 = (011111110)_2}$$

OR the Conversion done by that method.

$(376)_8 \longrightarrow (\ )_{10}$

first the octal no converted into decimal.

$\longrightarrow$ $(376)_8 = 3 \times 8^2 + 7 \times 8^1 + 6 \times 8^0$

$= 3 \times 64 + 7 \times 8 + 6 \times 1$

$= 192 + 56 + 6$

$(376)_8 = (254)_{10}$

Second the decimal no converted into binary

		Remainder
2	254	
2	127	0
2	63	1
2	31	1
2	15	1
2	7	1
2	3	1
2	1	1
	0	1

Thus the binary value

$(011111110)_2$

So $(376)_8 = (011111110)_2$

DETAILED LECTURE NOTES

Hexa decimal Numbers

It has a radix of 16 and use 16 symbols namely 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F.

The symbols A, B, C, D, E, F represent the decimal 10, 11, 12, 13, 14, 15 respectively. Each digit has a positional weight. The least weight is 16^0. The same format followed by the ~~...~~ hexadecimal conversion.

Ex (a) $(115)_{10}$

Division		Remainder
16	115	3
16	7	7
	0	

$(115)_{10} = (73)_{16}$

It can also be represented by 73H

) $(235)_{10} \rightarrow$

Diriston — Remaindor

16	235
16	14
	0

$11 \rightarrow B$

$14 \rightarrow E$

$(235)_{10} \longrightarrow (EB)_{16}$

(c) $2f3h \longrightarrow (\ )_{10}$

$(2f3)_{16} = 2 \times 16^2 + f \times 16^1 + 3 \times 16^0$

$= 2 \times 256 + 15 \times 16 + 3 \times 1$

$= 512 + 240 + 3$

$= (755)_{10}$

(d) $(1E0.2A)_{16} = (\ )_{10}$

integral pand 1E0

decimal equalent $= 0 \times 16^0 + 14 \times 16^1 + 1 \times 16^2$

$= 0 + 224 + 256 = 480$

fractional pand $=$ 2A

decimal equalent $= 2 \times 16^{-1} + 10 \times 16^{-2}$

$= 0.164$

decimal equalent of

$(1E0.2A)_{16} = (480.164)_{10}$

Hexadecimal - Binary Conversion

$(2D5)_{16} =$ 2 D 5

0010 1101 0101

Thus $(2D5)_{16} = (001011010101)_2$

for arriving the result each significant digit in the given number is replaced by its 4 bit binary equalent.

→ for reverse process the procedure would ~~start~~ from the least significant bit each group of 4 bit is replaced by its decimal equalent.

$(11110110101)_2 =$

111 1011 0101

7 B 5

$(11110110101)_2 = (7B5)_{16}$

Convert the following number:

a. $(11011.011)_2 \rightarrow (\ )_{16}$

same procedure followed for the conversion of this number.

1001 1011 . 0110

↓ ↓ ↓

1 B . 6

So $(11011.011)_2 = (1B.6)_{16}$

Hexadecimal to Octal Conversion

for convert a hexa decimal to octal the following steps can be used

→ convert the hexa decimal number to its binary equalent.

→ form group of 3 bit, starting from the LSB

→ write the equalent octal no for each group of 3 bit

$(47)_{16} = (0100\ 0111)_2$

$= (01000111)_2$

$= (107)_8$

Octal to Hexadecimal no.

for converting octal into binary charge every octal value using 3 binary bits

$(56)_8 =$ 101 110

$= (101110)_2$

→ convert $(101110) \rightarrow$ hexa decimal

group every 4 binary bits and calculate the value from left to right

$(101110)_2 =$ 10 1110

2 14

$(101110)_2 = (2E)_{16}$