CSE1003
Digital Logic and Design

Module 1 Introduction
Lecture 2

Dr. S. Hemamalini
Professor
School of Electrical Engineering
VIT Chennai

Module 1 Introduction 3 hours

- Number System
- Base Conversion
- Binary Codes
- Complements (Binary and Decimal)

Base Conversion Methods - Series substitution

Positional Weights Method

Each binary digit of the number is multiplied by its position weight and the product terms are added to obtain the decimal number.

Expand number in original base using

$$N = \sum_{i=-m}^{n-1} a_i r^i$$

$$N = a_{n-1}r^{n-1} + a_{n-2}r^{n-2} + \ldots + a_1 r^1 + a_0 + \cdots + a_{-m}r^{-m}$$

Most Significant Bit (MSB)

Least Significant Bit (MSB)

Binary to decimal conversion

Convert 11011.101_2 to decimal.

$11011.101 = 1\times2^4 + 1\times2^3 + 0\times2^2 + 1\times2^1 + 1\times2^0 + 1\times2^{-1} + 0\times2^{-2} + 1\times2^{-3}$

$= 16 + 8 + 0 + 2 + 1 + 0.5 + 0 + 0.125 = 27.625_{10}$

2^4 2^0 2^{-1} 2^{-3}

Decimal to Binary Conversion - Radix Divide Method

Converting decimal integer to binary

- To convert a decimal integer to binary, repeatedly divide by 2 (successive division) until the quotient is zero - Double-Dabble method.
- Last reminder is the MSB. Read the reminders in reverse order (bottom to top) to get the binary form of the number.

Converting decimal fraction to binary

- To convert a decimal fraction to binary, repeatedly multiply the fractional part by 2 till the fraction part of the product is zero or till the desired accuracy is obtained.
- The first integer obtained is the MSB. Read the integers from top to bottom to get the binary equivalent fraction.

Decimal to Binary Conversion - Radix Divide Method

Convert 163.875_{10} to binary.

Integer part conversion

	Quotient	Remainder	
163			
163/2	81	1	LSB
81/2	40	1	
40/2	20	0	
20/2	10	0	
10/2	5	0	
5/2	2	1	
2/2	1	0	
1/2	0	1	MSB

Most Significant Bit

Fractional part conversion

0.875

0.875×2	1.75	1 MSB
0.75×2	1.5	1
0.5×2	1.0	1 LSB

$163.875_{10} = 10100011.111_2$

Practice problem: Convert 105.15_{10} to binary

Octal to Binary Conversion

Octal to Binary Conversion

Replace each octal digit by its 3-bit binary equivalent.

Convert an octal to binary by substituting the binary equivalents for each digit.

$317.2_8 = 011\ 001\ 111.010_2$

Binary to Octal Conversion

- To convert binary to octal, arrange the bits in groups of three, starting from the binary point and working outward
- Insert leading or trailing zeros to complete the groups.
- Convert each group of three bits into its octal equivalent.

$011110110.1_2 = 011\ 110\ 110.100 = 366.4_8$

Octal to Binary Conversion

Convert 367.52_8 to binary.

$011\ 110\ 111 . 101\ 010_2$

Convert $010|101|111|001 . 011|100_2$ to octal.

$010\ 101\ 111\ 001 . 011\ 100$

$2\ 5\ 7\ 1 . 3\ 4_8$

Octal to decimal conversion

Multiply each digit in the octal number by the weight of its position and add all the product terms.

Convert 4057.06_8 to decimal.

$$4057.06_8 = 4\times8^3+0\times8^2+5\times8^1+7\times8^0+0\times8^{-1}+6\times8^{-2}$$

$$= 2095.09375_{10}$$

Decimal to Octal conversion

To convert the given decimal integer number to octal, successively divide the given number by 8 till the quotient is 0.
The last reminder is the MSD. Reminders read upwards give the equivalent octal integer number.

572.7341_8

Convert 378.93_{10} to octal.

Integer

	Q	R	
378/8	47	2	LSB
47/8	5	7	
5/8	0	5	MSB

Fraction

0.93×8	7.44	7 MSB
0.44×8	3.52	3
0.52×8	4.16	4
0.16×8	1.28	1 LSB.

Hex to Binary Conversion
Binary to Hex Conversion

Use the conversion table

Bin	Hex	Bin	Hex
0000	0	1000	8
0001	1	1001	9
0010	2	1010	A
0011	3	1011	B
0100	4	1100	C
0101	5	1101	D
0110	6	1110	E
0111	7	1111	F

Binary to Hex Conversion

1. Divide binary number into 4-bit groups.
2. Substitute hex digit for each group

$|01\ 1\ 0|0\ 0\ 0\ 1|1\ 1\ 0\ 0| \rightarrow 61C_{16}$

Hex to Binary Conversion

$1E3F_{16}$

$0001\,1110\,0011\,1111_2$

Hexadecimal to Decimal Conversion

Multiply each digit in the hexadecimal number by its position weight and add all those product terms.

$$5C7_{16} = 5 \times 16^2 + C \times 16^1 + 7 \times 16^0$$

$$= 5 \times 16^2 + 12 \times 16^1 + 7 \times 16^0$$

$$= 1479_{10}$$

$$A0F9.0EB_{16} = 41209.0572_{10}$$

Decimal to Hexadecimal Conversion
Radix Divide Method

- Successively divide the integer by 16 till the quotient is zero. Last reminder is MSB.
- Read the reminder from bottom to top and that gives the equ. Hexadecimal integer.
- Multiply the given fraction number by 16 till the product is zero or till the required accuracy is reached.
- First integer is the MSB. Read top to bottom to get the equ. fractional part.

Convert 2598.675_{10} to hexadecimal.

	Q	R	
2598/16	162	6	R LSB
162/16	10	2	2
10/16	0	10	A MSB

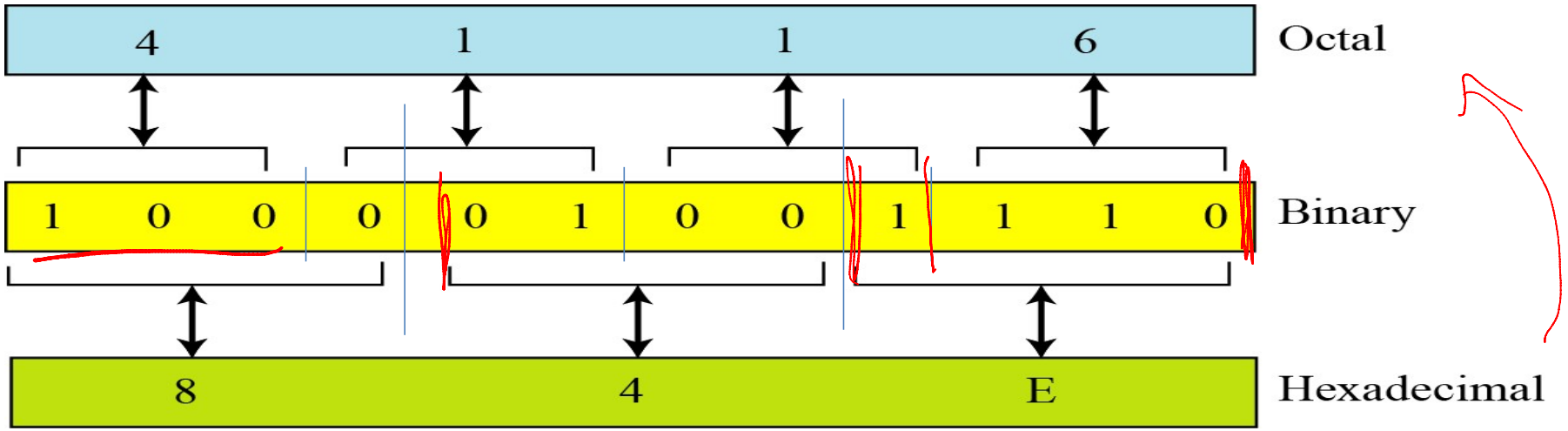
reading Hex.

$0.675 \times 16 = 10.8$ A
$0.800 \times 16 = 12.8$ C
$0.800 \times 16 = 12.8$ C
$0.800 \times 16 = 12.8$ C

Hex ↓

$2598.675_{10} = A26.ACCC_{16}$

Octal to hexadecimal and hexadecimal to octal conversion



Practice problems

1. Convert 756.603_8 to hexadecimal.
2. Convert $B9F.AE_{16}$ to octal.
3. Convert 10110111011_2 to hexadecimal.
4. Convert $4BAC_{16}$ to binary.