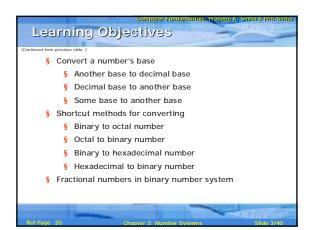


	Computer Fundamentals: Pradeep K. Sinha & Priti Sinha
Lea	rning Objectives
In th	is chapter you will learn about:
111 (is chapter you will learn about.
§	Non-positional number system
§	Positional number system
§	Decimal number system
§	Binary number system
§	Octal number system
§	Hexadecimal number system
	(Continued on next slide)



Number Systems Two types of number systems are: § Non-positional number systems § Positional number systems Non-positional Number Systems § Characteristics § Use symbols such as I for 1, II for 2, III for 3, IIII for 4, IIIII for 5, etc § Each symbol represents the same value regardless of its position in the number § The symbols are simply added to find out the value of a particular number § Difficulty § It is difficult to perform arithmetic with such a number system Positional Number Systems § Characteristics § Use only a few symbols called digits § These symbols represent different values depending on the position they occupy in the number

Positional Number Systems

- revious slide...)
- § The value of each digit is determined by:
 - 1. The digit itself
 - 2. The position of the digit in the number
 - 3. The base of the number system

(base = total number of digits in the number system)

§ The maximum value of a single digit is always equal to one less than the value of the base

Decimal Number System

Characteristics

- § A positional number system
- § Has 10 symbols or digits (0, 1, 2, 3, 4, 5, 6, 7, 8, 9). Hence, its base = 10
- § The maximum value of a single digit is 9 (one less than the value of the base)
- § Each position of a digit represents a specific power of the base (10)
- § We use this number system in our day-to-day life

(Continued on next slid

Decimal Number System

Example

 $2586_{10} = (2 \times 10^3) + (5 \times 10^2) + (8 \times 10^1) + (6 \times 10^0)$

= 2000 + 500 + 80 + 6

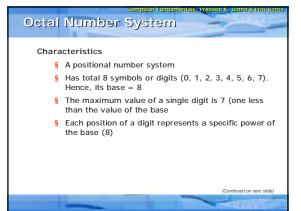
Characteristics § A positional number system § Has only 2 symbols or digits (0 and 1). Hence its base = 2 § The maximum value of a single digit is 1 (one less than the value of the base) § Each position of a digit represents a specific power of the base (2) § This number system is used in computers

Binary Number System entitued from previous side...) Example 10101₂ = (1 x 2⁴) + (0 x 2³) + (1 x 2²) + (0 x 2¹) x (1 x 2⁰) = 16 + 0 + 4 + 0 + 1 = 21₁₀

In order to be specific about which number system we are referring to, it is a common practice to indicate the base as a subscript. Thus, we write: 10101₂ = 21₁₀

Representing Numbers in Different Number

Sometimes of the stands for binary digit Sometimes of the stands of th



Octal Number System (Continued from previous side...) § Since there are only 8 digits, 3 bits (2³ = 8) are sufficient to represent any octal number in binary Example $2057_8 = (2 \times 8^3) + (0 \times 8^2) + (5 \times 8^1) + (7 \times 8^0)$ = 1024 + 0 + 40 + 7 $= 1071_{10}$

Hexadecimal Number System

Characteristics

- § A positional number system
- § Has total 16 symbols or digits (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F). Hence its base = 16
- § The symbols A, B, C, D, E and F represent the decimal values 10, 11, 12, 13, 14 and 15 respectively
- § The maximum value of a single digit is 15 (one less than the value of the base)

Hexadecimal Number System

- § Each position of a digit represents a specific power of the base (16)
- § Since there are only 16 digits, 4 bits (2⁴ = 16) are sufficient to represent any hexadecimal number in binary

Example

$$1AF_{16} = (1 \times 16^{2}) + (A \times 16^{1}) + (F \times 16^{0})$$

$$= 1 \times 256 + 10 \times 16 + 15 \times 1$$

$$= 256 + 160 + 15$$

$$= 431_{10}$$

Converting a Number of Another Base to a Decimal Number

Method

- Step 1: Determine the column (positional) value of each digit
- Step 2: Multiply the obtained column values by the digits in the corresponding columns
- Step 3: Calculate the sum of these products

Converting a Number of Another Base to a Decimal Number (Continued from previous side.) Example 4706₈ = ?₁₀ Common values multiplied with the corresponding digits = 4 x 512 + 7 x 64 + 0 + 6 x 1 digits = 2048 + 448 + 0 + 6 - Sum of these products

Converting a Decimal Number to a Number of Another Base

Division-Remainder Method

- Step 1: Divide the decimal number to be converted by the value of the new base
- Step 2: Record the remainder from Step 1 as the rightmost digit (least significant digit) of the new base number
- Step 3: Divide the quotient of the previous divide by the new base

(Continued on next slide

Converting a Decimal Number to a Number of Another Base

Step 4: Record the remainder from Step 3 as the next digit (to the left) of the new base number

Repeat Steps 3 and 4, recording remainders from right to left, until the quotient becomes zero in Step 3 $\,$

Note that the last remainder thus obtained will be the most significant digit (MSD) of the new base number

(Continued on next slide

Converting a Decimal Number to a Number of Another Base (Continued from previous side.)	
Example	
952 ₁₀ = ? ₈	
Solution: 8 952 Remainder	
119 S 0 14 7	
1 6 0 1	
Hence, 952 ₁₀ = 1670 ₈	
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- Andrew San - Andrew State Control of the Control	
Computer FundamentalSakradeep K, Sinna 3-Pritt Sinna	1
Converting a Number of Some Base to a Number of Another Base	
Method	
Step 1: Convert the original number to a decimal number (base 10)	
Step 2: Convert the decimal number so obtained to the new base number	
(Continued on next slide) Ref Page 27 Chapter 3: Number Systems. Slide 22/40	
nor eight at Coopures runnon systems. Since 23/40.	
	_
Converting a Number of Some Base to a Number	

Converting a Number of Some Base to a Number of Another Base

Step 2: Convert 209₁₀ to base 4

4	209	Remaind
	52	1
	13	0
	3	1
	0	3

Hence, $209_{10} = 3101_4$

So,
$$545_6 = 209_{10} = 3101_4$$

Thus, $545_6 = 3101_4$

Computer Fundamentals, Process & State & Pritt State Shortcut Method for Converting a Binary Number to its Equivalent Octal Number

Method

Step 1: Divide the digits into groups of three starting from the right

Step 2: Convert each group of three binary digits to one octal digit using the method of binary to decimal conversion

(Continued on next slide

Computer Fundamentals Produced & Sinna & Pritt Sinna Shortcut Method for Converting a Binary Number to its Equivalent Octal Number

Example

1101010₂ = ?₈

Step 1: Divide the binary digits into groups of 3 starting from right

<u>001</u> <u>101</u> <u>010</u>

Step 2: Convert each group into one octal digit

 $001_2 = 0 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 1$ $101_2 = 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 5$ $010_2 = 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = 2$

Hence, $1101010_2 = 152_8$

Shortcut Method for Converting an Octal Number to Its Equivalent Binary Number Method Step 1: Convert each octal digit to a 3 digit binary number (the octal digits may be treated as decimal for this conversion) Step 2: Combine all the resulting binary groups (of 3 digits each) into a single binary

Shortcut Method for Converting an Octal Number to Its Equivalent Binary Number

Example

562₈ = ?₂

Step 1: Convert each octal digit to 3 binary digits $5_8 = 101_2, \qquad 6_8 = 110_2,$ $2_8 = 010_2$

Step 2: Combine the binary groups

 $562_8 = \underline{101} \quad \underline{110} \quad \underline{010}$ 5 6

Hence, $562_8 = 101110010_2$

Shortcut Method for Converting a Binary Number to its Equivalent Hexadecimal Number

Method

Step 1: Divide the binary digits into groups of four

starting from the right

Step 2: Combine each group of four binary digits to one hexadecimal digit

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Shortcut Method for Converting a Hexadecimal Number to its Equivalent Binary Number

Method

- Step 1: Convert the decimal equivalent of each hexadecimal digit to a 4 digit binary number
- Step 2: Combine all the resulting binary groups (of 4 digits each) in a single binary number

(Continued on next slide

Shortcut Method for Converting a Hexadecimal Number to its Equivalent Binary Number

Example

 $2AB_{16} = ?_2$

Step 1: Convert each hexadecimal digit to a 4 digit binary number

$$2_{16} = 2_{10} = 0010_2$$

 $A_{16} = 10_{10} = 1010_2$
 $B_{16} = 11_{10} = 1011_2$

Shortcut Method for Converting a Hexadecimal Number to its Equivalent Binary Number

Hence, $2AB_{16} = 001010101011_2$

Fractional Numbers

 $\label{lem:fractional numbers} \textit{ are formed same way as decimal number system}$

In general, a number in a number system with base \boldsymbol{b} would be written as:

a_n a_{n-1}... a₀ . a₋₁ a₋₂ ... a_{-m}

And would be interpreted to mean:

 $a_n \ x \ b^n + \ a_{n-1} \ x \ b^{n-1} + ... + \ a_0 \ x \ b^0 + \ a_{-1} \ x \ b^{-1} + \ a_{-2} \ x \ b^{-2} + ... + \ a_{-m} \ x \ b^{-m}$

The symbols $\mathbf{a_{n}},\ \mathbf{a_{n-1}},\ \dots,\ \mathbf{a_{.m}}$ in above representation should be one of the b symbols allowed in the number system

Formation of Fractional Numbers in Binary Number System (Example)

Binary Point

Position 4 3 2 1 0 1 -2 -3 -4

Position Value 24 23 22 21 20 2-1 2-2 2-3 2-4

Quantity Represented

(Continued on next slide

Formation of Fractional Numbers in Binary Number System (Example) (Continued from protous side.) Example 110.101₂ = 1 x 2² + 1 x 2¹ + 0 x 2⁰ + 1 x 2⁻¹ + 0 x 2⁻² + 1 x 2⁻³ = 4 + 2 + 0 + 0.5 + 0 + 0.125 = 6.625₁₀

Computer Fundamentalls Analogy X, Slaria & Prill Slaria Formation of Fractional Numbers in Octal Number System (Example) Octal Point Position 3 2 1 0 - -1 -2 -3 Position Value 8³ 8² 8¹ 8⁰ 8-¹ 8-² 8-³ Quantity 512 64 8 1 ¹/₈ ¹/₆₄ ¹/₅₁₂ Represented

Computer Fundamentals Reputer System Formation of Fractional Numbers in Octal Number System (Example) Example 127.54₈ = 1 x 8² + 2 x 8¹ + 7 x 8⁰ + 5 x 8⁻¹ + 4 x 8⁻² = 64 + 16 + 7 + ⁵/₈ + ⁴/₆₄ = 87 + 0.625 + 0.0625 = 87.6875₁₀

Computer	Fundamentals: Pradeep K, Sinha & Priti Sinha
Key Words/Phrase	s
§ Base § Binary number system § Binary point	§ Least Significant Digit (LSD) § Memory dump § Most Significant Digit (MSD)
§ Bit § Decimal number system § Division-Remainder technique	§ Non-positional number system § Number system
§ Fractional numbers § Hexadecimal number system	§ Octal number system § Positional number system
Ref Page 34 Chapter 3: Nun	nber Systems Slide 40/40