

A decorative graphic on the left side of the slide, consisting of a complex network of stylized circuit lines in green, blue, and white. These lines connect various circular nodes and pads, some of which are larger and more prominent than others, creating a sense of depth and connectivity.

# Chapter 1

## DATA REPRESENTATION



# Complements

## Examples

- 10's C
  - $512790 = 487210$
  - $14672.3 = 85327.7$
- 7's C
  - $65172 = 12605$

## Examples

- 1's C
  - $011100 = 100011$
- 2's C
  - $010101 = 101011$
- 16's C
  - $59A1D = A65E3$

# Systems Used to Represent Negative Numbers

## Signed-Magnitude Representation

- A number consists of a magnitude and a symbol indicating whether the magnitude is positive or negative.

Examples:

$$+85 = 01010101_2$$

$$+127 = 01111111_2$$

$$-85 = 11010101_2$$

$$-127 = 11111111_2$$

# Systems Used to Represent Negative Numbers

## Signed-Complement System

- This system negates a number by taking its complement as defined by the system.

Examples:

$$+85 = 01010101_2$$

$$+127 = 01111111_2$$

$$-85 = 10101010_2 (1s)$$

$$-127 = 10000001_2 (2s)$$

A decorative graphic on the left side of the slide, consisting of a complex network of stylized circuit lines in green, blue, and white. These lines connect various circular nodes and pads, creating a sense of electronic connectivity. The pattern is dense and occupies the left third of the slide.

## Chapter 2

# COMPUTER ARITHMETIC



# Arithmetic in various Number Systems

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- Addition of numbers in any number system
  - Add numbers starting at the least significant digit.
  - Perform addition on numbers of the same number base.
- Subtraction of numbers
  - Must use complements



# Binary Addition

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- To add binary numbers:  $(X + Y)$ 
  - Get the SCR of the negative numbers
  - Add the two numbers
  - If the SCR used is:
    - 2's C: Discard end carry
    - 1's C: Add the end carry to the sum



# Example: Binary Addition

- Add the following numbers. Use 8 bits to represent each number.
  - $6 + 13$
  - $6 + (-13)$
  - $(-6) + 13$
  - $(-6) + (-13)$





# Example: Binary Addition

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- $6 + 13 = 19$

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0 0000110

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$$\begin{array}{r} 0\ 0000110 \\ +\ 0\ 0001101 \\ \hline \end{array}$$

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- $6 + (-13) = -7$

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- $6 + (-13) = -7$

$$\begin{array}{r} 0\ 0000110 \\ \phantom{+}\phantom{0\ 0001101} \end{array} \quad (1's)$$

# Example: Binary Addition

- $6 + 13 = 19$

$$\begin{array}{r} 0\ 0000110 \\ +\ 0\ 0001101 \\ \hline =\ 0\ 0010011 \end{array}$$

- $6 + (-13) = -7$

$$\begin{array}{r} 0\ 0000110 \\ +\ 1\ 1110010\ (1's) \\ \hline \end{array}$$

# Example: Binary Addition

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$$\begin{array}{r} 0\ 0000110 \\ +\ 0\ 0001101 \\ \hline =\ 0\ 0010011 \end{array}$$

- $6 + (-13) = -7$

$$\begin{array}{r} 0\ 0000110 \\ +\ 1\ 1110010\ (1's) \\ \hline =\ 1\ 1111000 \end{array}$$



# Example: Binary Addition

- $(-6) + 13 = 7$

(2's)

$6 = 0\ 0000110$

# Example: Binary Addition

- $(-6) + 13 = 7$

1 1111010 (2's)

*6 = 0 0000110*

# Example: Binary Addition

- $(-6) + 13 = 7$

$$\begin{array}{r} 1\ 1111010\ (2's) \\ +\ 0\ 0001101 \\ \hline \end{array}$$

$$6 = 0\ 0000110$$

# Example: Binary Addition

- $(-6) + 13 = 7$

$$\begin{array}{r} 1\ 1111010\ (2's) \\ +\ 0\ 0001101 \\ \hline =10\ 0000111 \end{array}$$

$$6 = 0\ 0000110$$

# Example: Binary Addition

- $(-6) + 13 = 7$

$$\begin{array}{r} 1\ 1111010\ (2's) \\ +\ 0\ 0001101 \\ \hline = \cancel{1}0\ 0000111 \end{array}$$

$$6 = 0\ 0000110$$

# Example: Binary Addition

- $(-6) + 13 = 7$

$$\begin{array}{r} 1\ 1111010\ (2's) \\ +\ 0\ 0001101 \\ \hline = \cancel{1}0\ 0000111 \end{array}$$

*6 = 0 0000110*

- $(-6) + (-13) = -19$

$$1\ 1111010\ (2's)$$

# Example: Binary Addition

- $(-6) + 13 = 7$

$$\begin{array}{r} 1\ 1111010\ (2's) \\ +\ 0\ 0001101 \\ \hline =\cancel{1}0\ 0000111 \end{array}$$

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$$\begin{array}{r} 1\ 1111010\ (2's) \\ +\ 1\ 1110011\ (2's) \\ \hline \end{array}$$

# Example: Binary Addition

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$$\begin{array}{r} 1\ 1111010\ (2's) \\ +\ 1\ 1110011\ (2's) \\ \hline =\ 11\ 1101101 \end{array}$$



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- $(-6) + 13 = 7$

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*6 = 0 0000110*

- $(-6) + (-13) = -19$

$$\begin{array}{r} 1\ 1111010\ (2's) \\ +\ 1\ 1110011\ (2's) \\ \hline = \cancel{1}1\ 1101101 \end{array}$$

# Examples: Addition

- $(999.5 + 281.6)_{10}$

$$\begin{array}{r} \phantom{+} \phantom{1} \phantom{1} \phantom{1} \\ 999.5 \\ + 281.6 \\ \hline 1281.1 \end{array}$$

# Examples: Addition

•  $(999.5 + 281.6)_{10}$

$$\begin{array}{r} \phantom{+} \phantom{1} \phantom{1} \phantom{1} \\ 999.5 \\ + 281.6 \\ \hline 1281.1 \end{array}$$

•  $(110.11 + 101010.11)_2$

$$\begin{array}{r} \phantom{+} \phantom{1} \phantom{1} \phantom{1} \phantom{1} \phantom{1} \\ 110.11 \\ + 101010.11 \\ \hline 110001.10 \end{array}$$

# Examples: Addition

- $(355.45 + 240.664)_8$

$$\begin{array}{r} 355.45 \\ + 240.664 \\ \hline = \end{array}$$

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$$\begin{array}{r} \phantom{+} 355.45 \\ + 240.664 \\ \hline = \phantom{000} 4 \end{array}$$

# Examples: Addition

- $(355.45 + 240.664)_8$

$$\begin{array}{r} \phantom{+} 355.45 \\ + 240.664 \\ \hline = \phantom{000} 34 \end{array}$$

# Examples: Addition

- $(355.45 + 240.664)_8$

$$\begin{array}{r} \phantom{+} \overset{1}{\phantom{0}} \overset{1}{\phantom{0}} \\ 355.45 \\ + 240.664 \\ \hline = 6.334 \end{array}$$

# Examples: Addition

- $(355.45 + 240.664)_8$

$$\begin{array}{r} \phantom{+} \overset{1}{3} \overset{1}{5} \overset{1}{5} . 45 \\ + 240.664 \\ \hline = 616.334 \end{array}$$



# Examples: Addition

•  $(355.45 + 240.664)_8$

$$\begin{array}{r} \phantom{+} \overset{1}{3} \overset{1}{5} \overset{1}{5}.45 \\ + 240.664 \\ \hline = 616.334 \end{array}$$

•  $(A0C.D + E72.9)_{16}$

$$\begin{array}{r} \phantom{+} A0C.D \\ + E72.9 \\ \hline = \end{array}$$

# Examples: Addition

•  $(355.45 + 240.664)_8$

$$\begin{array}{r} \phantom{+} \overset{1}{3} \overset{1}{5} \overset{1}{5} . 45 \\ + 240.664 \\ \hline = 616.334 \end{array}$$

•  $(A0C.D + E72.9)_{16}$

$$\begin{array}{r} \phantom{+} \overset{1}{A} 0 C . D \\ + E 7 2 . 9 \\ \hline = \phantom{000} . 6 \end{array}$$

# Examples: Addition

•  $(355.45 + 240.664)_8$

$$\begin{array}{r} \phantom{+} \overset{1}{3} \overset{1}{5} \overset{1}{5}.45 \\ + 240.664 \\ \hline = 616.334 \end{array}$$

•  $(A0C.D + E72.9)_{16}$

$$\begin{array}{r} \phantom{+} \overset{1}{A}0C.D \\ + E72.9 \\ \hline = 187F.6 \end{array}$$