1 Exercises

Exercise 1. What is the range of non-negative integers that can be represented using 16 bits (ie, binary digits).

Exercise 2. Express the decimal number 245 in binary, octal, and hexadecimal.

Exercise 3. Express the three numbers 1001000110 (binary), 1304 (octal), and 37B (hexadecimal), in decimal.

Exercise 4. Consider the decimal numbers $x = 77$ and $y = 84$.

a. Express x and y as 8-bit binary numbers.

b. Express $z = x + y$ as an 8-bit binary number.

c. Express $-z$ as an 8-bit binary number.

Exercise 5. What real number does 0271828001 represent?

Exercise 6. Consider the string "Chocolate".

a. Encode the string as a decimal sequence.

b. Encode the string as a binary sequence.

Exercise 7. Consider a 1-bit full adder (FA) with inputs x, y, and c_{in} (carry-in), and outputs z and c_{out} (carry-out). Use the minterm expansion algorithm to derive boolean functions $z = f(x, y, c_{in})$ and $c_{out} = g(x, y, c_{in})$ that respectively express the output z and c_{out} in terms of the inputs x, y, and c_{in}.

Exercise 8. For our 8-bit computer:

a. What is the 8-bit binary code for the instruction `mul 3 1 2` (multiply the values in registers 1 and 2, and store the result in register 3)?

b. What is the instruction corresponding to the 8-bit binary code `11011011`?

2 Solutions

Solution 1. $[0, 2^{16} - 1 = 65535]$

Solution 2. 11110101, 365, F5

Solution 3. 582, 708, 891

Solution 4.

a. $x = 01001101$ and $y = 01010100$

b. $z = 10100001$

c. $-z = 01011111$

Solution 5. $0.271828 \times 10^1 = 2.71828$

Solution 6.

a. 009 067 104 111 099 111 108 097 116 101

b. 00001001 01000011 01101000 01101111 01100011 01101111 01101100 01100001 01110100 01100101

Solution 7. The boolean functions $z = f(x, y, c_{in})$ and $c_{out} = g(x, y, c_{in})$:

$$\begin{aligned} z &= \bar{x} \cdot \bar{y} \cdot c_{in} + \bar{x} \cdot y \cdot \bar{c}_{in} + x \cdot \bar{y} \cdot \bar{c}_{in} + x \cdot y \cdot c_{in} \\ c_{out} &= \bar{x} \cdot y \cdot c_{in} + x \cdot \bar{y} \cdot c_{in} + x \cdot y \cdot \bar{c}_{in} + x \cdot y \cdot c_{in} \end{aligned}$$

Solution 8.

a. `mul 3 1 2` $\Longrightarrow$ `10110110`

b. `11011011` $\Longrightarrow$ `div 1 2 3` (divide the value in register 2 by the value in register 3 and store the result in register 1)