Exercise 1. Consider the 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 $z = f(x, y, c_{\text{in}})$ and $c_{\text{out}} = g(x, y, c_{\text{in}})$ that respectively express the outputs z and c_{out} in terms of the basic boolean functions.

Exercise 2. For each of the following boolean functions, write down the corresponding truth table, and then use the minterm expansion algorithm to express the function in terms of the basic boolean functions:

a. $z = \text{nor}(x, y)$ (ie, $z = \overline{\text{or}(x, y)}$)

b. $z = \text{nand}(x, y)$ (ie, $z = \overline{\text{and}(x, y)}$)

Exercise 3. Using the truth table for a full adder circuit as a model, write down the truth table for a 2-bit ripple-carry adder circuit.

Solutions

Solution 1. $z = \bar{x} \cdot \bar{y} \cdot c_{\text{in}} + \bar{x} \cdot y \cdot \bar{c}_{in} + x \cdot \bar{y} \cdot \bar{c}_{in} + x \cdot y \cdot c_{\text{in}}$ and $c_{\text{out}} = \bar{x} \cdot y \cdot c_{\text{in}} + x \cdot \bar{y} \cdot c_{\text{in}} + x \cdot y \cdot \bar{c}_{in} + x \cdot y \cdot c_{\text{in}}$

Solution 2.

a.

x	y	z
0	0	1
0	1	0
1	0	0
1	1	0

$z = \bar{x} \cdot \bar{y}$

b.

x	y	z
0	0	1
0	1	1
1	0	1
1	1	0

$z = \bar{x} \cdot \bar{y} + \bar{x} \cdot y + x \cdot \bar{y}$

Solution 3.

x_1	y_1	x_0	y_0	c_{in}	z_1	z_0	c_{out}
0	0	0	0	0	0	0	0
0	0	0	1	0	0	1	0
0	0	1	0	0	1	0	0
0	0	1	1	0	1	1	0
0	1	0	0	0	0	1	0
0	1	0	1	0	1	0	0
0	1	1	0	0	1	1	0
0	1	1	1	0	0	0	0
1	0	0	0	0	1	0	0
1	0	0	1	0	1	1	0
1	0	1	0	0	0	0	1
1	0	1	1	0	0	1	1
1	1	0	0	0	1	1	0
1	1	0	1	0	0	0	1
1	1	1	0	0	0	1	1
1	1	1	1	0	1	0	1