Combinatorial logic functions

Exercises Digital Design

Solution vs. Hints:
While not every response provided herein constitutes a comprehensive solution, some serve as helpful hints intended to guide you toward discovering the solution independently. In certain instances, only a portion of the solution is presented.

1 COM - Combinatorial function representations

1.1 Truth Table

Six different actions possible:

- no call
- already there
- go down
- go up
- door open elevator stays
- undefined

com/representation-01

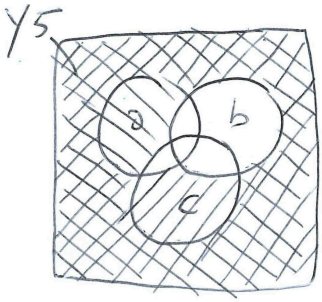
1.2 Truth Table from a Chonogram

$$y = a \oplus b \oplus c \tag{1}$$

com/representation-02

1.3 Representation by Venn diagram

Only the solution for y_5 is given:

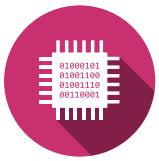


com/representation-03

1.4 Simplification by Venn diagram

ab (2)

com/representation-04



2 COM - Elementary logic functions

2.1 Switch Circuits

ab, $a + b$

com/logic-functions-01

2.2 Truth table of Elementary Functions

Each columns has two `'1'`.

com/logic-functions-02

2.3 Elementary Functions in a Truth Table

Not Available

com/logic-functions-03

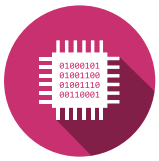
2.4 Number Decoding

$$\text{red} = \overline{c_2} + c_2\overline{c_1}\ \overline{c_0} \tag{3}$$

$$\text{orange} = \overline{c_2}c_1 + c_2\overline{c_1}\ \overline{c_0} \tag{4}$$

$$\text{green} = c_2(c_1 + c_0) \tag{5}$$

com/logic-functions-04



3 COM - Boolean algebra

3.1 Proofs

It can be either done with a Venn-Diagram, a Truthtable or Boolean Algebra.

com/algebra-01

3.2 De Morgan

$$\overline{a + b + \overline{c}d} = \overline{a}\ \overline{b}\ c + \overline{a}\ \overline{b}\ \overline{d} \tag{6}$$

com/algebra-02

3.3 Redundancy with the XOR function

$a = y \oplus b$

com/algebra-03

3.4 XOR function

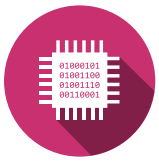
$\overline{a \oplus b} = \mathrm{ab} + \overline{a}\ \overline{b}$

com/algebra-04

3.5 Polynomial Form

$\overline{\overline{a}\overline{b} + \overline{b}\overline{c} + \overline{c}\ \overline{a}} = ab + bc + ca$

com/algebra-05



4 COM - Complete operators

4.1 Create a function using NAND gates

You need:
- 9 NAND with 2 inputs
- 1 NAND with 4 inputs

com/operators-01

4.2 Create a function using NAND gates

You need:
- 13 NAND with 2 inputs

com/operators-02

4.3 Create a function using NAND gates

You need:
- 12 NAND with 2 inputs for a minimal version

com/operators-03

4.4 NOR-Operator

- Inverter = 1 NOR
- AND = 3 NOR
- OR = 2 NOR

com/operators-04

4.5 Create a function using NOR gates

You need:
- 11 NOR with 2 inputs
- 1 NOR with 4 inputs

com/operators-05

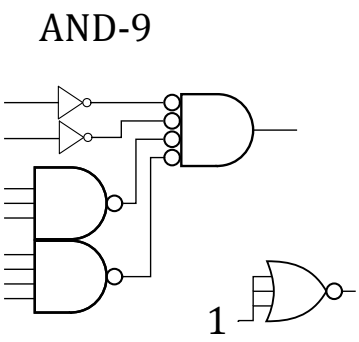
4.6 Create a function using inverting gates

You need:
- 9 NAND with 2 inputs
- 1 NAND with 4 inputs

com/operators-06

4.7 Versatile circuit

NAND, OR, NOR solution not available. Example AND-9:



com/operators-07

4.8 Creation of an XOR function

You need two 74HC7006 Chips

com/operators-08