

# Homework 2

Max marks: 110

Due on September 18, 2023, before class. Please submit both in brightspace and in person in paper this time. Grading on paper is easier.

**Problem 1** Please read Section 2.1-2.3 and Section 2.7 of Harris and Harris textbook. Write a statement to acknowledge that you have read and understood the assigned readings [5 marks].

**Problem 2** Consider the circuit in Figure 1. Write the circuit as:

1. Boolean expression [5 marks]
2. Truth table [10 marks]
3. Venn diagram. [5 marks]

(Total 20 marks)

**Problem 3** Represent the function in Figure 2 in the form of a

1. Venn diagram [5 marks]
2. Boolean expression [5 marks]
3. ANSI symbol network [5 marks]
4. ~~Timing diagram [5 marks]~~

Also, find its minimal sum-of-products form [5 marks]. (Total 25 marks).

**Problem 4** Use algebraic manipulation to simplify the function  $f = x_1x_3 + x_1x_2 + \bar{x}_1\bar{x}_2x_3 + \bar{x}_1\bar{x}_2\bar{x}_3$ . If the function is already in its simplest form, say so. [10 marks]

**Problem 5** Use algebraic manipulation to simplify the function  $f = x_1x_2\bar{x}_3 + x_1\bar{x}_2x_4 + x_1\bar{x}_2x_3\bar{x}_4$ . If the function is already in its simplest form, say so. [10 marks]

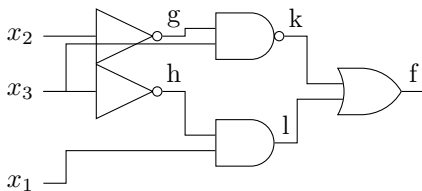


Figure 1: A three-input circuit

$x_1$	$x_2$	$x_3$	$f(x_1, x_2, x_3)$
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

Figure 2: A three-variable function

**Problem 6** Use algebraic manipulation to prove that  $(x + y) \cdot (x + \bar{y}) = x$ . [10 marks].

**Problem 7** Determine whether or not the following expressions are valid, i.e., whether the left- and right-hand sides represent the same function. [10 marks]

1.  $x_1\bar{x}_3 + x_2x_3 + \bar{x}_2\bar{x}_3 = (\bar{x}_1 + \bar{x}_2 + x_3)(x_1 + x_2 + \bar{x}_3)(\bar{x}_1 + x_2 + \bar{x}_3)$

2.  $(x_1 + x_3)(\bar{x}_1 + \bar{x}_2 + \bar{x}_3)(\bar{x}_1 + x_2) = (x_1 + x_2)(x_2 + x_3)(\bar{x}_1 + \bar{x}_3)$

**Problem 8** Design the simplest sum-of-products circuit that implements the function  $f(x_1, x_2, x_3, x_4) = \sum m(3, 4, 6, 7, 8)$ . [10 marks]

**Problem 9** Design the simplest product-of-sums circuit that implements the function  $f(x_1, x_2, x_3) = \prod M(0, 2, 5, 6)$ . [10 marks]