

# Homework 2

Max marks: 70

Due on September 23, 2022, before class. Please submit both in brightspace and in person in paper this time. Grading on paper is easier.

**Problem 1** Use algebraic manipulation to simplify the function  $f = x_1x_3 + x_1x_2 + \bar{x}_1x_2x_3 + \bar{x}_1\bar{x}_2\bar{x}_3$ . [10 marks]

**Problem 2** Use algebraic manipulation to simplify the function  $f = x_1\bar{x}_2\bar{x}_3 + x_1\bar{x}_2x_4 + x_1\bar{x}_2x_3\bar{x}_4$ . [10 marks]

**Problem 3** Represent the function in Figure 2 in the form of a Venn diagram and find its minimal sum-of-products form. [10 marks]

**Problem 4** Use algebraic manipulation to prove that  $(x + y) \cdot (x + \bar{y}) = x$ . [10 marks]

**Problem 5** 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 6** Design the simplest sum-of-products circuit that implements the function  $f(x_1, x_2, x_3, x_4) = \sum m(3, 4, 6, 8)$ . [10 marks]

**Problem 7** Design the simplest product-of-sums circuit that implements the function  $f(x_1, x_2, x_3) = \prod M(0, 2, 6)$ . [10 marks]

## References

[1] S. Brown and Z. Vranesic. *Fundamentals of Digital Logic with Verilog Design: Third Edition*. McGraw-Hill Higher Education, 2013.

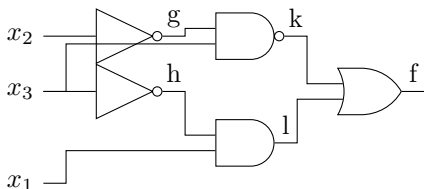


Figure 1: A three-input circuit

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