Homework 1

Max marks: 80

Due on September 8, 2021, before class.

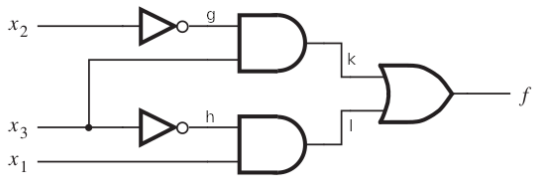

Figure 1: A three-input circuit

Row number	x_1	x_2	x_3	$f(x_1, x_2, x_3)$
0	0	0	0	0
1	0	0	1	1
2	0	1	0	0
3	0	1	1	0
4	1	0	0	1
5	1	0	1	1
6	1	1	0	1
7	1	1	1	0

Figure 2: A three-variable function

Problem 1 *Use algebraic manipulation to find the minimum sum-of-products expression for the function* $f = x_1x_3 + x_1\bar{x}_2 + \bar{x}_1x_2x_3 + \bar{x}_1\bar{x}_2\bar{x}_3$. *[1, Prob 2.12][10 marks]*

Problem 2 *Use algebraic manipulation to find the minimum sum-of-products expression for the function* $f = x_1\bar{x}_2\bar{x}_3 + x_1x_2x_4 + x_1\bar{x}_2x_3\bar{x}_4$. *[1, Prob 2.13][10 marks]*

Problem 3 *Draw a timing diagram for the circuit in Figure 1. Show the waveforms that can be observed on all wires (f, g, h, k, l) in the circuit.[1, Prob 2.8][10 marks]*

Problem 4 *Represent the function in Figure 2 in the form of a Venn diagram and find its minimal sum-of-products form. [1, Prob 2.17][10 marks]*

Problem 5 *Use algebric manipulation to prove that* $(x+y)\cdot(x+\bar{y}) = x$. *[1, Prob 2.2] [10 marks].*

Problem 6 *Determine whether or not the following expressions are valid, i.e., whether the left- and right-hand sides represent the same function. [1, Prob 2.7][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 7 *Design the simplest sum-of-products circuit that implements the function* $f(x_1, x_2, x_3) = \sum m(3, 4, 6, 7)$. *[1, Prob 2.21][10 marks]*

Problem 8 *Design the simplest product-of-sums circuit that implements the function* $f(x_1, x_2, x_3) = \prod M(0, 2, 5)$. *[1, Prob 2.22][10 marks]*

References

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