



Istanbul Technical University
Department of Computer Engineering

November 12, 2021

BLG 231E - Digital Circuits

Assignment 2

Due Date: Thursday, November 18, 2021, 23:59.

- Please write your solutions using a computer program. Points will be taken off for handwritten submissions.
- You may draw only the circuits by hand (or using a computer program if you want). If you draw figures by hand, use a ruler. PLEASE BE NEAT! If we cannot read or follow your solution, no partial credit will be given.
- **Consequences of plagiarism:** Any cheating will be subject to disciplinary action.
- **No late submissions** will be accepted. Do not send your solutions by e-mail. The only valid submission method is uploading your file to Ninova before the deadline.
- **Submissions:** Submit your solution PDFs to Ninova. Please **write your full name** (first name and last name) **and Student ID** into your solution PDFs.

If you have any questions, please e-mail **Mert Sülük** (suluk20@itu.edu.tr).

1. Assume that a robot has a circuit that determines its current mood. Its happiness **Y** depends on the following criteria:

H: Health,
M: Money,
L: Leisure,
F: Friends

These criteria are shown as inputs in the table given below. Each combination generates a happiness value.

	H	M	L	F	Y
0	0	0	0	0	0
1	0	0	0	1	0
2	0	0	1	0	0
3	0	0	1	1	1
4	0	1	0	0	0
5	0	1	0	1	0
6	0	1	1	0	1
7	0	1	1	1	1
8	1	0	0	0	0
9	1	0	0	1	0
10	1	0	1	0	1
11	1	0	1	1	1
12	1	1	0	0	1
13	1	1	0	1	1
14	1	1	1	0	1
15	1	1	1	1	1

In the table, for the inputs, a “0” value for a criterion means that specific criterion is not satisfied, and a “1” means that it is satisfied. For the output, $Y=0$ means the robot is unhappy, and $Y=1$ means it is happy.

- a. Write the expressions of *happiness* (Y) in
 - (i) the first canonical form
 - (ii) the second canonical forms
- b. Minimize the expression of happiness in the first canonical form using axioms and theorems of Boolean algebra. Show all steps in your minimization and write the name of the axiom/theorem/property you use on the right-hand side of the expression at each step.

2. Draw the circuit for the minimized expression in (1.b) using
 - a. 2-input AND, NOT, and OR gates only.
 - b. 2-input NAND gates only.

Show all steps, and explain your work leading up to the final circuit in 2-3 sentences for (a) and (b) separately.

3. In terms of the robot’s happiness, what could be the advantages and/or disadvantages of using “NAND gates only” compared to “AND, NOT, and OR gates only”?