Istanbul Technical University

Department of Computer Engineering

September 30, 2022

BLG 231E - Digital Circuits

Assignment 1

Due Date: Thursday, October 6, 2022, 23:59.

- Please prepare your homework using a computer. Points will be taken off for handwritten submissions.
- **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.** We will only accept files that have been uploaded to the official Ninova e-learning system before the deadline. Do not risk leaving your submission to the last few minutes.
- **Submissions:** Submit your solution PDFs to Ninova. Please **write your full name** (first name and last name) **and Student ID** inside the box below.

Student ID	**:**
Full Name	**:**

If you have any questions, please e-mail teaching assistant
- **Mert Sülük for Part-1 (suluk20@itu.edu.tr)**
- **Kıymet Kaya for Part-2 (kayak16@itu.edu.tr)**

Part 1 – Computer Arithmetic

1) a) Using **signed** 2's-complement representation, convert the decimal numbers $(-\mathbf{102})$ and $(-\mathbf{27})$ to **8-bit binary** integers. Show ALL work.

b) Carry out the **binary** operations given below, and explain your answers using terms such as *carry*, *borrow*, and *overflow*. To interpret the results, use only binary numbers.

i. **(-102) + (-27)**

ii. **(-102) – (-27)**

iii. **(27) – (102)**

Part 2 – Boolean Algebra

2) Simplify each Boolean expression using algebraic manipulation (axioms and theorems). Show ALL work.
Show the steps of the simplification, and **write which axiom/theorem you used in each step** next to the simplification.

a) $(\mathbf{Y} + \overline{\mathbf{X}}\,\overline{\mathbf{Z}})(\mathbf{X} + \overline{\mathbf{Y}} + \overline{\mathbf{Z}})(\overline{\mathbf{X}} + \mathbf{Y})$

b) $\overline{\mathbf{X}}\,\overline{\mathbf{Y}}\,\overline{\mathbf{Z}}\,\overline{\mathbf{T}} + \mathbf{X}\,\overline{\mathbf{Y}}\,\mathbf{T} + \overline{\mathbf{X}}\,\overline{\mathbf{Y}}\,\mathbf{Z} + \mathbf{X}\,\mathbf{Z}\,\overline{\mathbf{T}} + \mathbf{X}\,\overline{\mathbf{Y}}\,\mathbf{Z}\,\mathbf{T} + \overline{\mathbf{X}}\,\overline{\mathbf{Y}}\,\overline{\mathbf{Z}}$