November 6, 2020

Istanbul Technical University

Department of Computer Engineering

BLG 231E - Digital Circuits

Assignment 1

Due Date: Thursday, November 12, 2020, 23:59.

- Please **write neatly**.
- 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.

Submissions: Submit your solution PDFs to Ninova.

Part 1 – Computer Arithmetic

1. ***A*** and ***B*** are two 8-bit binary integers, and ***B*** = **1101 1001**. For the operation ***A*** **-** ***B***, answer the following questions:
   - **a.** If ***A*** and ***B*** are *signed* binary integers, what are the **i)** largest and **ii)** smallest decimal values of **A** that yield valid results (that can be represented using 8 bits) after the operation? Explain your answer briefly.
   - **b.** Write the binary representation for the largest value of the signed ***A*** you found in **(a.i)**. Carry out the binary operation ***A*** **-** ***B*** using **2's complement**, and show that the result is valid using binary numbers only.
   - **c.** If ***A*** and ***B*** are *unsigned* binary integers, what are the **i)** largest and **ii)** smallest binary values of **A** that yield valid results after the operation? Explain your answer briefly.

2. ***A*** and ***B*** are two 8-bit, **signed**, binary integers, and ***A*** **= 1011 1100**. If we perform the operation ***A*** **+** ***B*** ,
   - **a.** What are the **i)** largest and **ii)** smallest decimal values of ***B*** that yield valid results after the operation? Explain your answer briefly.
   - **b.** Write the binary representation for the smallest value of the signed ***B*** you found in **(a.ii)**. Perform the binary operation ***A*** **+** ***B***, and show that the result is valid using binary numbers only.

Part 2 – Boolean Algebra

3. Simplify the following logic expressions using axioms, properties, and theorems of Boolean algebra.

   a. $E(a,b,c) = a\bar{b}c + ab\bar{c} + abc + \bar{a}bc$

   b. $E(a,b,c,d) = \bar{a}b\bar{d} + bcd + ab\bar{c} + a\bar{b}d + b\bar{c}\bar{d} + ad + \bar{a}bc$