Tutorial 5
Boolean Algebra

Exercise 1

1. Simplify the following expressions:
   - $S1 = (a + b).(\overline{a} + \overline{b})$
   - $S2 = a.b + \overline{a}.\overline{b} + \overline{a}.b$
   - $S3 = (a + \overline{b}).(a + b) + c.(\overline{a} + b)$
   - $S4 = (a + c + d).(b + c + d)$
   - $S5 = (a.\overline{b} + a.b + a.c).(\overline{a}.\overline{b} + a.b + a.\overline{c})$
   - $S6 = (a + \overline{b} + c).(a + \overline{c}).(\overline{a} + \overline{b})$
   - $S7 = a.b.c + a.\overline{b}.\overline{c} + \overline{a}.b.\overline{c} + \overline{a}.b.c$
   - $S8 = a.b.c + a.\overline{b}.c + a.b.\overline{c}.d$
   - $S9 = a + b.c + \overline{a}.(\overline{b} + \overline{c}).(a.d + c)$

2. Calculate and simplify the complement of S1, S5 and S6.
3. Design the NOT, AND, and OR gates by using only NAND gates, then only NOR gates.

Exercise 2

1. Write down the following expressions by using minterm canonical forms:
   - $S1 = \overline{a}.b.d + a.\overline{b}.\overline{c} + a.b.c$
   - $S2 = a.c.d + b.c.\overline{d} + \overline{b}.\overline{c}.d$
   - $S3 = (\overline{a} + \overline{c}).(a + \overline{d} + c).b.\overline{c}$
   - $S4 = b.c.(a + \overline{d}) + \overline{b}.d.(a + \overline{c})$

2. Write down the following expressions by using maxterm canonical forms:
   - $S1 = (a + c).(\overline{a} + b + c)$
   - $S2 = a.b + a.\overline{c} + \overline{a}.\overline{b}.c$

Exercise 3

Prove that the following identities are true:

- $\overline{a.c + b.\overline{c}} = \overline{a}.c + \overline{b}.\overline{c}$
- $(a + b).(\overline{a} + c).(b + c) = (a + b).(\overline{a} + c)$
- $\overline{(a + c).(b + \overline{c})} = (\overline{a} + c).(\overline{b} + \overline{c})$

Exercise 4

Let us consider the following binary variables: *A*, *B*, *C*. Write down an expression that is 1 when the number of variables being 1 is odd (simplify with EXCLUSIVE OR).