Tutorial 4
Boolean Algebra

Exercise 1

Simplify the expressions below by using the algebraic method.

- S1 = $(a + b).(\overline{a} + \overline{b})$
- S2 = $\overline{a.b + \overline{a}.\overline{b} + \overline{a}.b}$
- S3 = $(a + \overline{b}).(a + b) + c.(\overline{a} + b)$
- S4 = $\overline{\overline{a}.\overline{c}.\overline{d} + \overline{b}.\overline{c}.\overline{d}}$
- S5 = $(a + \overline{b}.\overline{c}).\overline{a.b}$
- S6 = $a.b.c + a.\overline{b}.\overline{c} + \overline{a}.b.\overline{c} + \overline{a}.b.c$
- S7 = $a + b.c + \overline{a}.(\overline{b} + \overline{c}).(a.d + c)$

Exercise 2

Design the NOT, AND, OR and XOR gates by using only NAND gates.

Exercise 3

1. Write down the following expressions by using minterm canonical forms.
   - S1 = $a.c.d + b.c.\overline{d} + \overline{b}.\overline{c}.d$
   - S2 = $(\overline{a} + \overline{c}).(a + \overline{d} + c).b.\overline{c}$
   - S3 = $b.c.(a + \overline{d}) + \overline{b}.d.(a + \overline{c})$
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 4

Prove that the following identities are true.

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

Exercise 5

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).