Tutorial: Boolean algebra and circuits

Aim

The aim of this tutorial is for students to become confident using basic Boolean algebra and basic logic circuits.

Questions

1. Process the following sequences using a NOT gate.

a) 11001
b) 10001111
c) 101100111000

2. Consider the following three pairs of sequence bits:

i) 110001 and 101101

ii) 10001111 and 00111100

iii) 101100111000 and 000111001101

Show how each pair would be processed by

a) an OR gate

b) an AND gate

3. Convert the Boolean expression $E = x(xy' + x'y + y'z)$ into sum-of-products form.

4. Draw the logic circuit for the following Boolean expressions.

a) $E_1 = A\overline{B} + AB\overline{C}$
b) $E_2 = \overline{A + B\overline{C}} + B$

5. Determine the Boolean expression corresponding to the figure Question 5 - Circuit, which is the size and depth of the circuit? Simplify the boolean expression in order to obtain a simpler circuit. Which is the size and depth of the simplified circuit?

6. Use the laws of Boolean algebra to simplify the following Boolean expressions.

a) $y(x + x'y)$
b) $(xy' + x')'$
c) $(x + yz)(x' + z)$

7. Draw the digital circuit which corresponds to the Boolean expression $(x' + y)'(x + y)$. Can this be simplified?

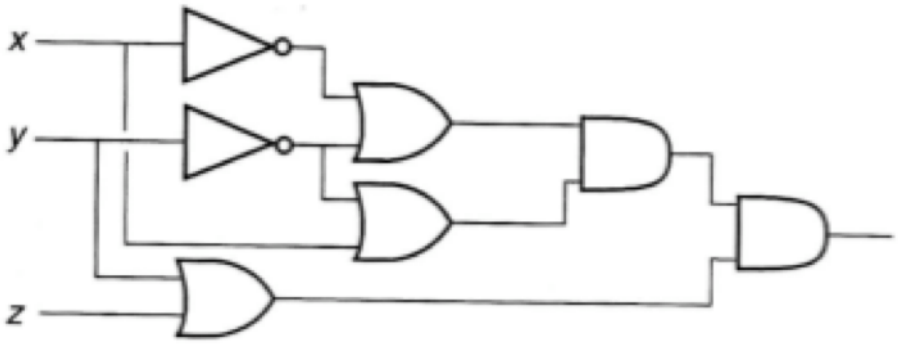

Figure 1: Question 5 - Circuit

Extension tasks

8. Logic circuits are used to build computers. An interesting application of simple circuits is making adders, that is, a circuit that adds binary numbers together. In the lecture you would have seen a half adder, which adds 2 bits together. See if you can find out how a full adder would work, which adds 2 bits and a carry bit together (similar to what we did when adding binary numbers).