



HACETTEPE UNIVERSITY
ELECTRICAL AND ELECTRONICS ENGINEERING
ELE237 FUNDAMENTALS OF DIGITAL SYSTEMS

Experiment 1 – Implementation of Boolean Functions and Gate-Level Minimization in VHDL

Preliminaries:

- 1) Students who will attend to this experiment are assumed to know:
 - Basic number systems and Boolean algebra
 - Basic combinational logic operations and gates
 - Basic VHDL operators and operands
- 2) Please study the related pages on the book.

Work :

- **Basic Logic Functions are “and, nand, or, nor, not, xor, xnor”**
- 1) Convert following decimal numbers to 8-bit binary numbers
 - a. 201
 - b. 78
 - c. 58
 - d. 6
 - e. 84
 - 2) Convert following 8-bit binary numbers to decimal and hexadecimal
 - a. 11011111
 - b. 11101001
 - c. 00011001
 - d. 10110001
 - e. 10010101
 - 3) For the function given in sum-of-minterms form,
$$F(A, B, C) = \Sigma(1, 2, 4, 5, 7)$$
 - a. Implement the function in VHDL without any simplification.
 - b. Write a simple test bench that shows at least three different cases of inputs and corresponding outputs.

- 4) Consider the logic circuit shown in Figure 1.
- Derive and simplify the Boolean expressions for T_1 , T_2 , T_3 and T_4 . Find the expressions for outputs F_1 and F_2 as functions of four inputs.
 - Construct the truth table with all combinations of four inputs. List the binary values for T_1 through T_4 and outputs F_1 and F_2 in the truth table.
 - Find the simplified Boolean expressions for outputs using Karnaugh maps.
 - Implement this circuit in VHDL with all four inputs and two outputs.
 - Write a simple test bench that shows at least four different cases of inputs and corresponding outputs.

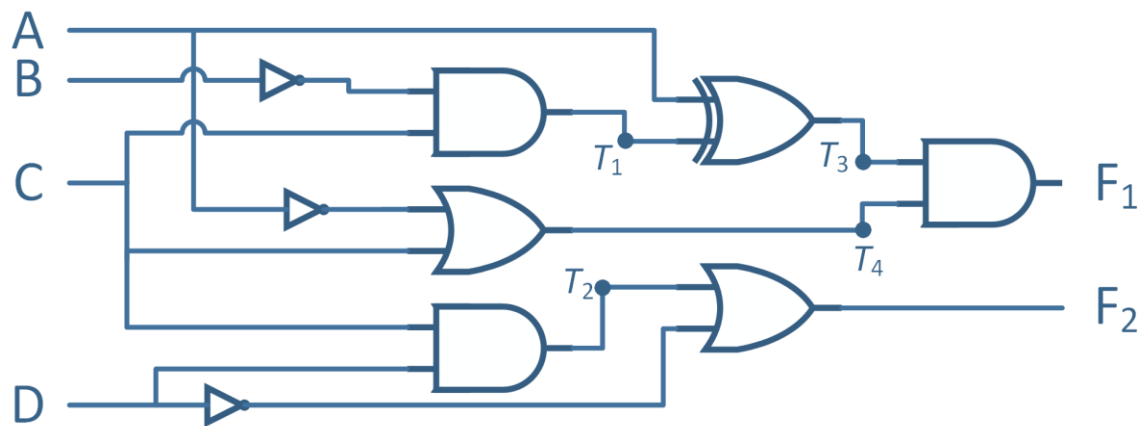


Figure 1

- 5) There is a digital device, that contains a combinational logic circuit. This system has 3 binary inputs (x , y , z) and 3 binary outputs (A , B , C). An electrical and electronics engineering student (like you) observes this system by applying all possible inputs and recording all possible outputs.

After some observation of the behavior of the system, student has reached following results:

- ✓ If the binary inputs are 0,1,2 or 3 (in decimal), output is one greater than the input.
- ✓ If the inputs are applied as 4, 5, 6 or 7 output is one less than the input.

With all these given information,

- Find the combinational logic inside this digital circuit using the truth table approach.
- Obtain the simplified Boolean functions for each output as a function of inputs using Karnaugh maps.
- Implement this circuit in VHDL.
- Write a simple test bench that shows at least four different cases of inputs and corresponding outputs.