Ryerson University

Department of Electrical Engineering

COE328 – Digital Systems

Lab 2

10 Marks (1 week)

Function Implementation and Minimization

Due Date: Week 5

1 Objectives

- Implementation of simple logic functions using NAND gates
- Design, build and test logic functions using the Karnaugh map method

2 Pre-Lab Preparation

Implementation of the simple logic functions with NAND gates

1. Determine 2 ways to implement an inverter with a 2-input NAND gate.
2. Implement a 3-input NAND gate function using 2-input NAND gates only, draw schematics.
3. Implement a 2-input OR function using 2-input NAND gates only, draw schematics.
4. (A) Implement the function $Z = f(A, B) = (A + B)\overline{AB}$ using one 2-input OR gate, one 2-input AND gate and one 2-input NAND gate.
   (B) Implement the same function Z with only NAND gates.
   (C) Make up the truth table for the function. What is the common name of this function?
   (D) Expand and simplify the Boolean equation to express Z as a sum of products. Implement the sum of products using only NAND gates. Note: It is possible to do so with 4 NAND gates and no additional inverters.

3 Laboratory Work

Construct the customized function assigned to you by the instructor. Then simplify the customized function using K-map simplification method. Simulate (with available CAD software in the lab) and showcase the results to the instructor.

Customized Functions:

Each student is assigned a part of a customized function, which when paired by student number (last 4 digits of your student number), constructs a complete function which can be utilized in Part 3 of the lab work.

$F_1 = \sum([last\ 4\ digits], 10, 11, 12)$
$F_2 = \sum([last\ 4\ digits], 10, 11, 13)$
$F_3 = \sum([last\ 4\ digits], 10, 11, 14)$
$F_4 = \sum([last\ 4\ digits], 10, 11, 15)$
$F_5 = \sum([last\ 4\ digits], 10, 12, 13)$
$F_6 = \sum([last\ 4\ digits], 10, 12, 14)$
$F_7 = \sum([last\ 4\ digits], 10, 12, 15)$
$F_8 = \sum([last\ 4\ digits], 10, 13, 14)$
$F_9 = \sum([last\ 4\ digits], 10, 13, 14)$

$F_{10} = \sum([last\ 4\ digits], 10, 14, 15)$
$F_{11} = \sum([last\ 4\ digits], 11, 12, 13)$
$F_{12} = \sum([last\ 4\ digits], 11, 12, 14)$
$F_{13} = \sum([last\ 4\ digits], 11, 12, 15)$
$F_{14} = \sum([last\ 4\ digits], 11, 13, 14)$
$F_{15} = \sum([last\ 4\ digits], 11, 13, 15)$
$F_{16} = \sum([last\ 4\ digits], 11, 14, 15)$
$F_{17} = \sum([last\ 4\ digits], 12, 13, 14)$
$F_{18} = \sum([last\ 4\ digits], 12, 14, 15)$

Tutorial:

J. Sammy with student number 512344395 is assigned with function 13.
His customized function will consist of last for digits of the student number and the assigned function.

J. Sammy's function: $F = \sum(3, 4, 5, 9, 11, 12, 15)$