University of Windsor
Faculty of Science
School of Computer Science

COMP-2650
Computer Architecture I: Digital Design
Winter 2022

Assignment#	Date	Title	Due Date	Grade Release Date
Lec 08	Week 08	**Karnaugh Map**	March 16, 2022, Wednesday 4 AM EDT	March. 21, 2022

The objectives of the lecture (weekly) assignments are to practice on topics covered in the lectures as well as improve the student's critical thinking and problem-solving skills in ad hoc topics that are closely related but not covered in the lectures. Lecture assignments also help students with research skills, including the ability to access, retrieve, and evaluate information (information literacy.)

Deliverables

You should answer 2 of the below questions based on your preference using an editor like MS Word, Notepad, and the likes or pen in papers. In the latter case, you have to write and scan the papers clearly and merge them into a single file. In the end, you have to submit all your answers in one single pdf file `lec08_UWinID.pdf` containing the question ids for the answer. Please note that if your answers cannot be read, you will lose marks. Please follow the naming convention as you lose marks otherwise. Instead of UWinID, use your own UWindsor account name, e.g., mine is hfani@uwindsor.ca, so my submission would be: `lec08_hfani.pdf`

Lecture Assignments

(Select Only 2 Questions based on your preference)

Use K-Map method for all simplification tasks!

1. Simplify the following Boolean functions, using three-variable maps:
   a) F(x, y, z) = ∑(0, 2, 4, 5)
   b) F(x, y, z) = ∑(0, 2, 4, 5, 6)
   c) F(x, y, z) = ∑(0, 1, 2, 3, 5)
   d) F(x, y, z) = ∑(1, 2, 3, 7)

2. Simplify the following Boolean expressions, using three-variable maps:
   a) xy + x'y'z' + x'yz'
   b) x'y' + yz + x'yz'
   c) x'y + yz' + y'z'
   d) x'yz + xy'z' + xy'z

3. Simplify the following Boolean functions, using Karnaugh maps:
   a) F (A, B, C, D) = ∑ (4, 6, 7, 15)
   b) F (A, B, C, D) = ∑ (3, 7, 11, 13, 14, 15)
   c) F (w, x, y, z) = ∑ (2, 3, 12, 13, 14, 15)
   d) F (w, x, y, z) = ∑ (11, 12, 13, 14, 15)
   e) F (w, x, y, z) = ∑ (8, 10, 12, 13, 14)

4. Simplify the following Boolean expressions, using four-variable maps:
   a) w'z + xz + x'y + wx'z
   b) AD' + B'C'D + BCD' + BC'D
   c) AB'C + B'C'D' + BCD + ACD' + A'B'C + A'BC'D
   d) wxy + xz + wx'z + w'x

5. Find the minterms of the following Boolean expressions by first plotting each function in a map:
   a) xy + yz + xy'z
   b) C'D + ABC' + ABD' + A'B'D
   c) wyz + w'x' + wxz'
   d) A'B + A'CD + B'CD + BC'D'

6. Convert the following Boolean function from a sum-of-products form to a simplified product-of-sums form: $F(x, y, z, w) = \sum(0, 1, 2, 5, 8, 10, 13)$

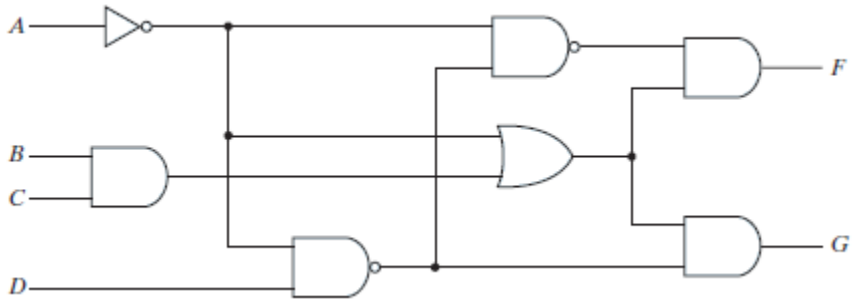
7. Simplify the following Boolean functions:
   a) $F(A, B, C, D) = \prod(1, 3, 5, 7, 13, 15)$
   b) $F(A, B, C, D) = \prod(1, 3, 6, 9, 11, 12, 14)$

8. Simplify the following functions, and implement them with two-level NOR gate circuits:
   a) $F = wx' + y'z' + w'yz'$
   b) $F(w, x, y, z) = \sum(0, 3, 12, 15)$
   c) $F(x, y, z) = [(x + y)(x + z)]'$

9. Draw the simplified NOR-only circuit for the following expression: $CD(B + C) A + (BC' + DE')$

10. Draw the simplified NAND-only circuit for the following expression: $w(x + y + z) + xyz$

11. Obtain the simplified Boolean expressions for output F and G in terms of the input variables in this circuit:



12. Design a *simplified* circuit with three inputs, x, y, and z, and three outputs, A, B, and C. When the binary input is 0, 1, 2, or 3, the binary output is one greater than the input. When the binary input is 4, 5, 6, or 7, the binary output is two less than the input.

13. A **majority circuit** is a circuit whose output is equal to 1 if the input variables have more 1's than 0's. The output is 0 otherwise. Design a *simplified* 3-input majority circuit by finding the circuit's truth table, Boolean equation, and a logic diagram.