



UNIVERSITY OF TEHRAN
Electrical and Computer Engineering Department
Digital Logic Design, ECE 367 / Digital Systems I, ECE 894
Spring 1399-1400
Homework 4
Boolean Algebra and Karnaugh-Map Basics

Name:

Date:

Username:

1. Minimize the following function using NOT, 2-input and 3-input NAND gates. the delays of these gates are #6, #5, and #8 NS respectively.
 - a. Write SystemVerilog description of this circuit using SystemVerilog primitives.
 - b. Calculate the worst-case delay for the minimized circuit.
 - c. Using the worst-case delay, write SystemVerilog description of this circuit using an **assign** statement.
 - d. Find input transitions that the circuit of Part a and Part c have different timing behaviors.

$$f(a,b,c,d) = \sum_m (2, 3, 4, 6, 8, 9, 12, 13)$$

2. For the given circuit, A) list all potential static hazards, B) list the logical hazards including their duration, the time they occur and input transition causing them, C) of all logical hazards, list those that are also considered as electrical hazards, and D) if the output gate drives two gates similar to its own input, then which of the logical hazards also become electrical hazard?

$$f(a,b,c,d) = \sum_m (2, 3, 4, 6, 8, 9, 12, 13)$$

3. Minimize the following function using NOT, 2-input and 3-input NAND gates. the delays of these gates are #6, #5, and #8 NS respectively. For the given circuit, A) list all potential static hazards, B) list the logical hazards including their duration, the time they occur and input transition causing them, C) of all logical hazards, list those that are also considered as electrical hazards, and D) if the output gate drives two gates similar to its own input, then which of the logical hazards also become electrical hazard?

$$f(a,b,c,d) = \sum_m (2, 3, 4, 6, 8, 9, 12, 13)$$

4. Show all minimal two-level SOP minimizations for the following function.

$$f(a,b,c,d) = \sum_m (2, 3, 4, 6, 8, 9, 11, 12, 13), d(7, 15)$$

5. Show all minimal two-level POS minimizations for the following function.

$$f(a,b,c,d) = \sum_m (2, 3, 4, 6, 8, 9, 11, 12, 13), d(7, 15)$$

6. Use tabular QM minimization method to reach the minimal realization of the function shown below. Show all necessary steps and tables.

$$f(a,b,c,d) = \sum_m (2, 3, 4, 6, 8, 9, 11, 12, 13), d(7, 15)$$

7. Show all forms of two-level POS minimizations for the following function.

$$f(a,b,c,d) = \prod_M (2, 3, 4, 6, 8, 9, 11, 12, 13), d(7, 15)$$

8. Show all forms of two-level SOP minimizations for the following function.

$$f(a,b,c,d) = \prod_M (2, 3, 4, 6, 8, 9, 11, 12, 13), d(7, 15)$$