JOINT INSTITUTE
交大密西根学院

Ve270 Introduction to Logic Design

Homework 3

Assigned: June 1, 2017

Due: June 8, 2017, at the beginning of the class.

The homework should be submitted in hard copies.

1. Problem 2.56 (15 points)

   (For Exercise 2.54, See Homework 2)

2.56 Consider the museum security alarm function of Exercise 2.54, but for a museum with 10 rooms. A truth table is not a good starting point (too many rows), nor is an equation describing when the alarm should sound (too many terms). However, the inverse of the alarm function can be straightforwardly captured as an equation. Design the circuit for the 10-room security system by designing the inverse of the function, and then just adding an inverter before the circuit's output.

2. Problem 2.57 (15 points)

2.57 A network router connects multiple computers together and allows them to send messages to each other. If two or more computers send messages simultaneously, the messages "collide" and must be re-sent. Using the combinational design process of Table 2.5, create a collision detection circuit for a router that connects 4 computers. The circuit has 4 inputs labeled `M0` through `M3` that are `1` when the corresponding computer is sending a message and `0` otherwise. The circuit has one output labeled `C` that is `1` when a collision is detected and `0` otherwise.

TABLE 2.5 Combinational logic design process.

Step			Description
Step 1: Capture behavior		*Capture the function*	Create a truth table or equations, whichever is most natural for the given problem, to describe the desired behavior of each output of the combinational logic.
Step 2: Convert to circuit	2A	*Create equations*	This substep is only necessary if you captured the function using a truth table instead of equations. Create an equation for each output by ORing all the minterms for that output. Simplify the equations if desired.
	2B	*Implement as a gate-based circuit*	For each output, create a circuit corresponding to the output's equation. (Sharing gates among multiple outputs is OK optionally.)

3. Problem 2.60 (15 points)

2.60 A car has a low-tire-pressure sensor that outputs the current tire pressure as a 5-bit binary number. Create a circuit that illuminates a "low tire pressure" indicator light (by setting an output `T` to `1`) when the tire pressure drops below 16. Hint: you might find it easier to create a circuit that detects the inverse function. You can then just append an inverter to the output of that circuit.

4. Problem 2.74 (15 points)

2.74 A house has four external doors, each with a sensor that outputs `1` if its door is open. Inside the house is a single LED that a homeowner wishes to use to indicate whether a door is open or closed. Because the LED can only show the status of one sensor, the homeowner buys a switch that can be set to 0, 1, 2, or 3 and that has a 2-bit output representing the switch position in binary. Create a circuit to connect the four sensors, the switch, and the LED. Use at least one mux (a single mux or an *N*-bit mux) or decoder. Use block symbols, each with a clearly defined function, such as "2x1 mux," "8-bit 2x1 mux," or "3x8 decoder"; do not show the internal design of a mux or decoder.

5. Show how four 2-to-1 and one 4-to-1 MUXs could be connected to form an 8-to-1 MUX. (5 points)

6. Show how to make a 4-to-1 MUX using an 8-to-1 MUX. (5 points)

7. Use one 4-to-1 MUX and one inverter to implement a digital circuit for Problem 2.40. (5 points) (See Homework 2 for Problem 2.40)

8. Use one 3-by-8 decoder to implement a digital circuit for Problem 2.40. (10 points)

9. Design an 8-bit ALU described in the table on PPT slide 23 in lecture notes for Topic 5 (10 points)

10. Problem 2.77 (b) (5 points)

2.77 Determine the critical path of the following specified circuits. Assume that each AND and OR gate has a delay of 1 ns, each NOT gate has a delay of 0.75 ns, and each wire has a delay of 0.5 ns.

(a) The circuit of Figure 2.37.

(b) The circuit of Figure 2.41.

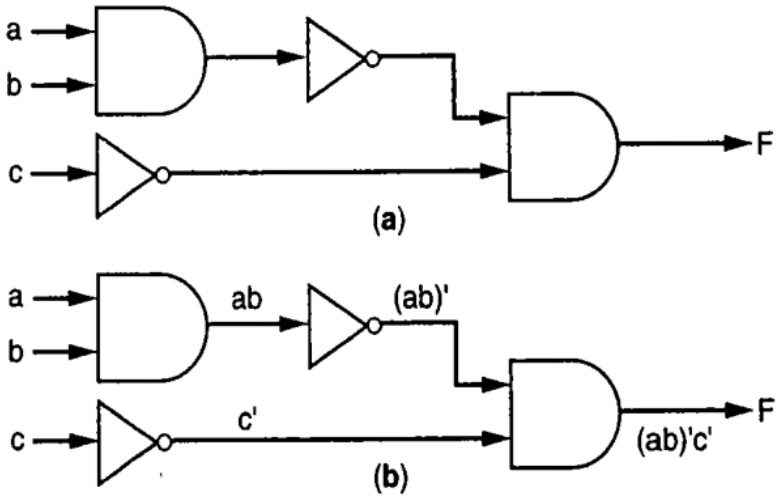

Figure 2.41 Converting a circuit to an equation: (a) original circuit, and (b) circuit with gates' output expressions labeled.