

Logic Synthesis & Verification, Fall 2014

National Taiwan University

Problem Set 5

Due on 2014/12/24 before lecture.)

1 Factored Form

Prove or disprove the following statements.

- (a) (10%) Any factored form expression with n literals can be implemented with a complex CMOS gate with $2n$ transistors.
- (b) (10%) Any complex CMOS gate with $2n$ transistors, each of which is controlled by some input, can be functionally expressed by a factored form with n literals.

2 Weak Division

(10%) Given an expression F and a divisor G , suppose $F = G \cdot H + R$ by weak division, that is, $H = F/G$. Prove that H and R are unique.

3 [Kernelling and Factoring]

(10%) Consider the expression $F =$

$$aefh + aegh + aei + bef h + beg h + bei + cdefh + cdegh + cdei.$$

Compute $\text{KERNEL}(0, F)$ with literals ordered alphabetically. Draw the kernelling tree (as in the slides) and list the kernels and their corresponding co-kernels.

4 [SDC and ODC]

(15%) Consider the Boolean network of Figure 1.

- (a) Write down a Boolean formula for the SDC of the entire network.
- (b) Write down a Boolean formula for the satisfiability don't cares SDC_4 of Node 4. Since SDC_4 is imposed by the fanins of Node 4, the formula should depend on variables $x_1, \dots, x_4, y_1, \dots, y_3$. How can you make SDC_4 only depend on y_1, y_2, y_3 such that we can minimize Node 4 directly?
- (c) Compute the observability don't cares ODC_4 of Node 4.

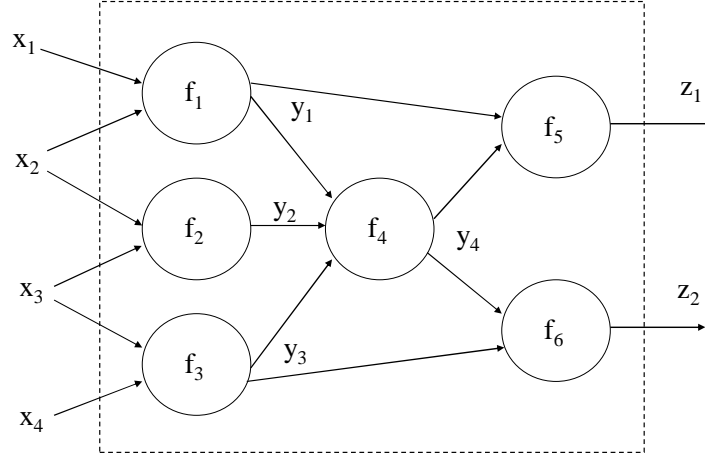


Fig. 1. A Boolean network, where $f_1 = x_1x_2$, $f_2 = x_2 \vee x_3$, $f_3 = \neg(x_3x_4)$, $f_4 = \neg y_1 \neg y_2 y_3 \vee y_1 y_2 \neg y_3$, $f_5 = y_1 \vee y_4$, and $f_6 = y_3 y_4$.

5 [Don't Cares in Local Variables]

(20%) Consider the Boolean network of Figure 1. Suppose the XDC for z_1 is $\neg x_1 \neg x_2 \neg x_3 \neg x_4$ and that for z_2 is $x_1 x_2 x_3 x_4$.

- Compute the don't cares D_4 of Node 4 in terms of its local input variables y_1 , y_2 , and y_3 . (Note that in general the computation of ODC may be affected by XDC especially when there exist different XDCs for different primary outputs.)
- Based on the computed don't cares, what is the best implementable function for Node 4 (in terms of the literal count and cube count in SOP)?

6 [Complete Flexibility]

(25%) Consider the Boolean network of Figure 1. Let $Y = \{y_1, y_2, y_3\}$.

- Suppose the XDC for z_1 is $\neg x_1 \neg x_2 \neg x_3 x_4$ and that for z_2 is $x_1 x_2 \neg x_3 x_4$. Write down the specification relation $S(X, Z)$.
- What is the influence relation $I(X, y_4, Z)$ of Node 4?
- What is the environment relation $E(X, Y)$ of Node 4?
- What is the complete flexibility $CF_4(Y, y_4)$ of Node 4?
- Is the previously computed don't care set D_4 of Node 4 subsumed by CF_4 ?