Logic Synthesis & Verification, Fall 2011

National Taiwan University

Problem Set 3

Due on 2011/11/09 before lecture

1 [Operation on Cube Lists]

(15%) Maintaining cube orthogonality helps to ensure irredundant cube list. Given two orthogonal cube lists, design an algorithm that performs AND operation while maintaining cube orthogonality. Can AND operation on two cube lists benefit from maintaining their individual orthogonalities? Why or why not?

2 [Symmetry and Transitivity]

(20%) Two types of variable symmetries of a Boolean function are defined as follows.

S1: $f(\ldots, x, y, \ldots) = f(\ldots, y, x, \ldots)$
S2: $f(\ldots, x, y, \ldots) = f(\ldots, \neg y, \neg x, \ldots)$

For a Boolean function $f(x_1, \ldots, x_n)$, do S_1 and S_2 form equivalence relations over the variables $X = \{x_1, \ldots, x_n\}$? Note that an equivalence relation R must be reflexive, i.e., $(a, a) \in R$ for all $a \in X$, symmetry, i.e., $(a, b) \in R \rightarrow (b, a) \in R$, and transitive, i.e., $(a, b) \in R$ and $(b, c) \in R \rightarrow (a, c) \in R$.

3 [Unate Cover]

Prove or disprove the following statements:

(a) (10%) Any unate cover without single-cube containment must be a prime cover.
(b) (10%) In the Boolean matrix reduction of the Quine-McCluskey method, column domination cannot happen for a completely specified function.

4 [Incompletely Specified Functions and Generalized Cofactor]

(15%)

(a) Let $F_1 = (f_1, d_1, r_1)$ and $F_2 = (f_2, d_2, r_2)$ be two incompletely specified functions. Express their disjunction $F_1 \vee F_2$ in terms of the triplet.
(b) Show that $co(f \vee g, h) = co(f, h) \vee co(g, h)$.

5 [Prime Generation]

(15%) Apply Unate Recursive Paradigm to generate all the prime implicants of the following cover.

$$\{a'b'c'd', a'bc'd', abc'd, abcd', abcd, ab'cd, a'bc'd, a'b'c'd\}$$

6 [Quine-McCluskey]

(15%) Let $f = w'x'y'z' + wx'z' + wxz + w'x'yz$ with don't care set $d = w'xyz' + wx'yz + w'xyz$. Use the Quine-McCluskey procedure to minimize f. Show results at each step (i.e. list the primes, give the matrix and show how the minimum cover is found).