COE 405, Term 041

COE 561 Digital System Design and Synthesis

HW# 3

Due date: Tuesday, Nov. 23

Q.1. Consider the logic network defined by the following expressions:

$$x = a\,d' + a'\,b' + a'\,d' + b\,c + b\,d' + a\,c$$

$$y = a + b$$

$$z = a'\,c' + a'\,d' + b'\,c' + b'\,d' + e$$

$$u = a'\,c + a'\,d + b'\,d + e'$$

(i) Substitute y into f_x by performing the algebraic division f_x/f_y. Show all steps. Determine the number of literals saved. Compare your solution with the result obtained by running the sis command ***resub –d*** (resubstitute without complement).

(ii) Compute all kernels and co-kernels of z and u. Extract a multiple-cube subexpression common to f_z and f_u. Show all the steps. Determine the number of literals saved. Compare your solution with the result obtained by running the sis command ***gkx***.

Q.2. Consider the logic network defined by the following expressions:

$$x = a\,b\,c\,f + e\,f\,c + d\,e$$

$$y = a\,c\,d\,e\,f + b\,d\,e\,f$$

$$z = b\,c\,d + a\,c\,f$$

(i) Determine the cube-variable matrix and all prime rectangles.

(ii) Determine the minimum-literal network that can be derived by cube extraction. Determine the number of literals saved. Compare your solution with the result obtained by running the sis command ***gcx***.

Q.3. Consider the following function:

$$x = b\,d + c\,d + b\,e + c\,e + a\,f\,d + a\,f\,e + a\,b\,g + a\,c\,g + a\,f\,g$$

(i) Find a quick factor of *x* by using the first level-0 kernel found. Assume that input variables are sorted in lexicographic order. Determine the number of literals obtained. Compare your solution with the result obtained by running the sis commands ***factor –q x***; ***print_factor; print_stats –f***.

(ii) Find a good factor of *x* based on using the best kernel. Determine the number of literals obtained. Compare your solution with the result obtained by running the sis commands ***factor –g x***; ***print_factor; print_stats –f***.

(iii) Decompose *x* using quick decomposition based on using the first level-0 kernel found. Determine the number of literals obtained. Compare your solution with the result obtained by running the sis commands ***decomp –q.*** Compare your solution to the factored solution obtained in (i).

(iv) Decompose *x* using good decomposition based on using based on using the best kernel. Determine the number of literals obtained. Compare your solution with the result obtained by running the sis commands ***decomp –g.*** Compare your solution to the factored solution obtained in (ii).

(v) Run the sis command ***fx*** and compare the solution obtained to that obtained in (iii) and (iv).

Q.4. Consider the logic network defined by the following expressions::

$$x = a'\,b'\,c\,d + a'\,b'\,c'\,d' + a\,c\,d' + a\,c'\,d + b\,c\,d' + b\,c'd$$

$$y = a'\,b'\,c + a'\,b'\,d + a\,c'\,d' + b\,c'\,d'$$

(i) Compute all double-cube divisors of *x* and *y* along with their bases.

(ii) Apply the fast extraction algorithm based on extracting double-cube divisors along with complements or single-cube divisors with two-literals. Show all steps of the algorithm. Determine the number of literals saved. Compare your solution with the result obtained by running the sis commands ***fx.***

(iii) Run the sis commands gkx followed by gcx and compare the solution obtained to that obtained in (ii).

Q.5. Consider the logic network defined by the following expressions:

$$d = b'$$

$$f = (a+d)'$$

$$e = (c\,a)'$$

$$x = f\,e$$

$$y = d \oplus e$$

Inputs are {a, b, c} and output are {x, y}.

(i) Assume CDC_{in} = abc'. Compute CDC_{out}.

(ii) Compute the ODC sets for all internal and input vertices, assuming that the outputs are fully observable.

Q.6. Consider the logic network defined by the following expressions:

$$u = a\,b' + b\,c$$

$$x = a\,u + b$$

$$y = a'u' + c'$$

Inputs are {*a, b, c*} and outputs are {*x, y*}.

(i) Compute the SDC set and ODC set for node *u*.

(ii) Simplify *u* using its ODC set.

(iii) Simplify *x* and *y* using the SDC set.

(iv) Apply the sis command ***full_simplify*** and compare the solution obtained to what you obtained as a result of applying steps (ii) and (iii).

Q.7. Consider the logic network defined by the following expressions:

$$o = e\,g$$

$$e = (a + b)'$$

$$g = d + c$$

$$d = a\ \ b$$

Inputs are {*a*, *b*, *c*} and output is {*o*}.

(i) Consider the network perturbation replacing d by 0, i.e. δ= a b ⊕ 0 = a b. Determine if this perturbation is feasible or not.

(ii) Is the fault ***d stuck-at-0*** testable. If it is testable find all tests detecting the fault. If the fault is untestable optimize the network by eliminating redundancy.

(iii) Is the fault ***e stuck-at-1*** testable. If it is testable find all tests detecting the fault. If the fault is untestable optimize the network by eliminating redundancy.