ECE/CS - 5740/6740: Logic Synthesis & Optimization
Practice questions for the Final - Spring 2019

These are questions given to you for practice.

1) Boolean Bi-decomposition: Consider the Boolean functions $F = de + b'd + a'd + a'c$.
   a) Perform a non-trivial AND bi-decomposition of $F = D \wedge Q$, by finding a suitable D and Q.
   b) Perform an XNOR decomposition of F as $F = D\overline{\oplus}Q$.
2) Solve Problem 8, chapter 8, in the textbook.
3) Solve problem 31, pp. 534 in the textbook (FSM minimization).
4) Consider the circuit shown in Fig. 1. The numerical values next to the logic gates represent their propagation delays.

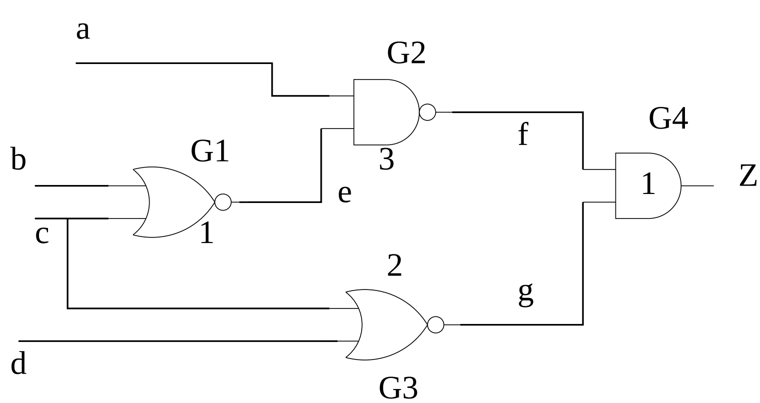

Fig. 1. Example for static and dynamic sensitization

   a) Find the topologically longest path(s) in the circuit. What is its delay?
   b) Can the longest path(s) be statically sensitized? In other words, is the longest path *statically false?*
   c) However, can an "event" propagate on these statically un-sensitizable path(s) at all? In other words, is the statically unsensitizable path also a truely false timing path? Demonstrate your answer on the circuit.
5) In the circuit of Fig. 1, change the delay of the gate $G3$ from 2 to 4 units. Now, identify the topological critical paths in the circuit. Which of these paths are truely the timing critical paths? In other words, by changing the delay of gate $G3$, does a true path become false?
6) Consider the finite state machine shown in Table I.

   The set of maximal compatibles for this FSM is already computed and made available to you; and the set of *maxcomps* is: $\{(ACD), (BC), (BE), (DE)\}$. Given this set of maxcomps, compute

TABLE I

STATE TRANSITION TABLE OF FSM M1

Present State	Next State, Output			
	I_1	I_2	I_3	I_4
A	-,-	-,-	E, 1	-,-
B	C, 0	A, 1	B,0	-,-
C	C, 0	D,1	-, -	A,0
D	-, -	E, 1	B, -	-,-
E	B,0	-,-	C, -	B,0

all the *prime compatibles* and their *class sets*. Subsequently, formulate the problem as a binate covering problem and construct the matrix. Just construct the matrix, no need to solve it to reduce the machine: actually, the solution (reduced machine) is given in the notes I scanned from Kohavi's book for you (machine M_7, pp. 342-343).

7) **Dichotomy-based encoding:** Derive a minimum length encoding satisfying the following constraint matrix:

$$M = \begin{array}{c} \begin{array}{cccc} a & b & c & d \end{array} \\ \begin{pmatrix} 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 1 \end{pmatrix} \end{array}$$

Show that your Encoding is Valid.