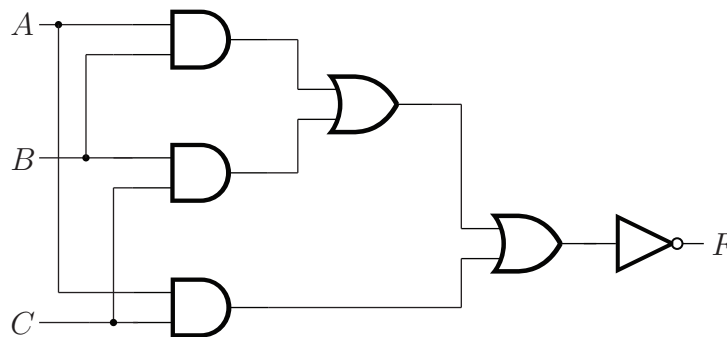


Problem Set 9 (rev C)
Due Friday (5pm), April 27, 2012

- Given the following truth table, find the minimal SOP expression. Then realize the expression using CMOS logic with the fewest possible transistors. *Hint:* Realize the complementary function in one gate using a pull-down and pull-up network. Use DeMorgan's laws to realize the pull-down from the pull-up. It should have no more than eight transistors, including inverters for inverted inputs.

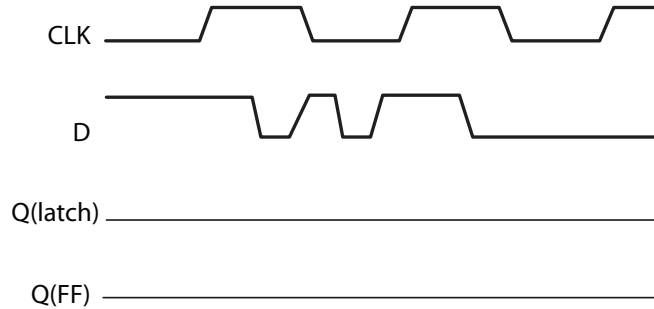
A	B	C	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

- Consider the following logic circuit. Write the equivalent Boolean expression. Then realize it in CMOS logic using the minimum number of transistors (it should have no more than ten transistors, including inverters).



- Consider the logic circuit from the previous problem again. (a) Recall that any logic function can be realized using NAND gates only. Derive the equivalent Boolean logic function using only NAND gates and draw out the corresponding logic gate circuit. (b) Now do the same using NOR gates only.

4. Draw the output of a flip flop and of a latch for the given input and clock waveforms. Assume the initial state of Q is 0.



5. Design a simple elevator controller using a finite state machine (FSM). Suppose the elevator can be in one of four states, depending on whether it is on the ground or first floor, and whether its door is closed or open. It can take in two inputs, one for the close/open door button, and the other for the up/down button.
- Let S_1 represent the floor that the elevator is on, either ground (0) or first (1). Let S_0 represent whether the door is closed (0) or open (1).
 - Ex: $S_1S_0 = 01_b$ is the state in which the elevator is open on the ground floor.
 - Let I_1 represent the button to go either down (0) or up (1). Let I_0 represent the close (0) or open (1) door button. I_1 takes action before I_0 .
 - Ex: $I_1I_0 = 11_b$ tells the elevator to go up a floor and open the door.
 - If we try to go up from the first floor or go down from the ground floor, the elevator does not move.
 - The elevator can only move if its door is closed ($S_0 = 0$). If we try to move the elevator while the door is open, we stay in the same state (nothing happens).
- (a) Draw the state transition diagram with all four states S_1S_0 and all possible inputs I_1I_0 for each state.
- (b) Write the truth table corresponding to your diagram. It should have six columns, two for the inputs (I_1, I_0), two for the current state (S_1, S_0), and two for the next state (S'_1, S'_0).
- (c) Write the state transition logic for S'_1 and S'_0 as a pair of Boolean equations in terms of the other four variables.
- (d) (Optional) Construct the circuit realization of the complete FSM using registers.