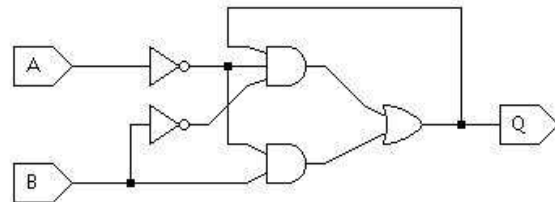# Sequential Circuits Review

Draft 26 October 2020

The sequential Circuits exam is the week of 2 November. No problems are due for credit.

1. Review the Sequential Circuits homework.

2. Complete the characteristic table for the circuit shown below:

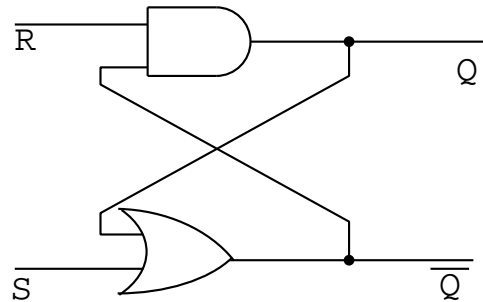| A_n	B_n	Q_n	Q_{n+1}
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

What fundamental circuit has the same characteristic table?

3. Use Boolean Algebra to show how the circuit in problem 2 is equivalent to one of the fundamental circuits used to build CPUs.

4. Complete the characteristic table for the circuit shown below: Note, there is no clock pulse here. Your answers should show the states Q and $\bar{Q}$ after they have reached a steady state given R, S, and current values of Q and $\bar{Q}$. If the given inputs will produce a non-deterministic output (i.e., the output depends on which gate changes first), write "random" in the row.

R	S	Q_{now}	$\bar{Q}_{now}$	Q_{next}	$\bar{Q}_{next}$
0	0	0	0		
0	0	0	1		
0	0	1	0		
0	0	1	1		
0	1	0	0		
0	1	0	1		
0	1	1	0		
0	1	1	1		
1	0	0	0		
1	0	0	1		
1	0	1	0		
1	0	1	1		
1	1	0	0		
1	1	0	1		
1	1	1	0		
1	1	1	1		

5. Choose a row labeled "random", and explain why the output is random.

6. Show how to build a SR latch (clocked or unclocked).

7. Show how to build a D latch (clocked or unclocked).

8. Show how to build a D flip-flop from two D latches.

9. Show how to add an enable input to a D latch or flip-flop.

10. Design a sequential circuit to compute the score of a game of bowling. This circuit will take as input the number of pins knocked down and produce as output (1) the current score, and (2) the current frame number.

    In general, the score is the total number of pins knocked down. However, the score for a strike is 10 plus the total number of pins knocked down by the next two balls. The score for a spare is 10 plus the number of pins knocked down by the next ball.