Digital Design

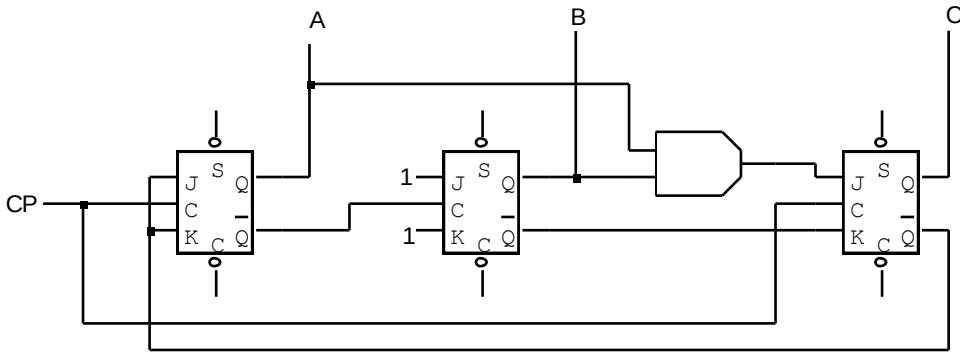
(a) Consider the following combinational circuit implementing the parity check on 8 inputs x1,…, x8

- What is the total number of tests to detect stuck-at-1 logic fault on input line x1 ?
- What is the total number of tests to detect stuck-at-1 logic fault on input line x8 ?
- Consider the following 'complex' fault model: single stuck-at-1 fault can occur ***either*** on line x1 ***or*** on line x8. What is the total number of tests to detect this 'complex' logic fault ?
- Consider the following 'complex' fault model: single stuck-at-1 fault can occur on **both** lines x1 and x8. What is the total number of tests to detect this 'complex' logic fault ?

SOLUTION
(i) input x1 should be set to x1= 0 and all other inputs can assume 2**7 different values → total number of tests is 2**7
(ii) input x8 should be set to x8= 0 and all other inputs can assume 2**7 different values → total number of tests is 2**7
(iii) inputs x1 and x8 should be set to x1x8= 00 and all other inputs can assume 2**6 different values → total number of tests is 2**6
(iv) there are no tests to detect this fault.

Grading: 0.5 pts for each part (i) – (iv)

(b) Consider the ripple counter shown below. Assume that all flip-flops are positive edge-triggered. Show the transition diagram for this counter, and clearly show the transition states. Determine the counting sequence for this ripple counter assuming the initial state 000. Is this counter self-starting?
Note: the counter is self-starting if the states in the counting sequence can be reached from any other state in the transition diagram.

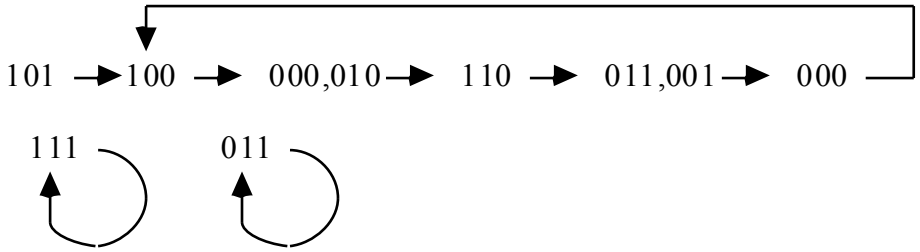


SOLUTION

Operation table:

- A is toggled when CP goes positive and C=0.
- B is toggled when A goes from 1 to 0.
- C is clocked when CP goes positive;
  it is set when ABC=11-, cleared when ABC=-0-, and unchanged when ABC=01-.

The complete transition diagram is shown below:



Assuming the initial state 000, the counting sequence (of stable states) is:

000 →100→010→110→001→back to 000

Transition states are indicated in red color:

000 →100 →000→010→110→011→001→back to 000

The counter is NOT self-starting.

Grading: 2 pts total.
Points Breakdown:

- Transition diagram + operation table ~ 1.5 pts
- counting sequence ~ 0.25 pts
- self-starting question ~ 0.25pts