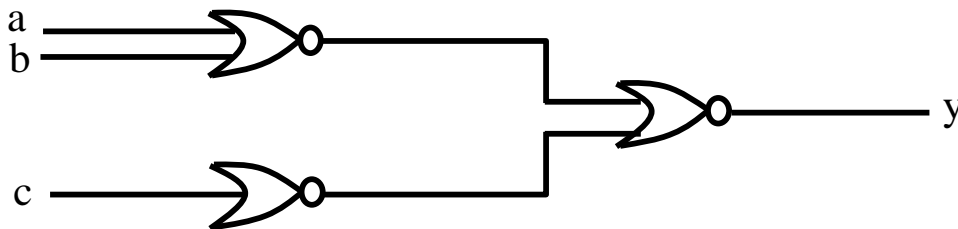


1. (11 points)
 Consider a 5-state system where the states are labeled as 0, 1, 2, 3, and 4, respectively. The system will receive either an ADD signal or a DOUBLE signal. On ADD, it moves to the state that has label one larger than that of the current state; on DOUBLE, it goes to the state whose label is double of the current state. Both add and double operations are in modulo 5. For example, at state 3, on ADD, it moves to $3+1=4$; on DOUBLE, it moves to $3*2=1 \pmod{5}$. In this problem, we will implement this system as a sequential circuit using D flip-flops and other necessary logic gates.
- (3 points) Draw the state transition diagram of this system.
 - (2 points) Draw the state transition table for the same system. Assume all the states are encoded in binary.
 - (3 points) Derive each flip-flop input function in the sum of product format with the minimum number of literals.
 - (2 points) Draw the logic diagram of this sequential circuit.
 - (1 point) In your design, what will be the next state if all the D flip-flops have value "1" as their content and the system receives signal ADD?

2. (3 points)
 Convert the following NOR implementation circuit to NAND implementation. Use as few NAND gates as possible.



3. (3 points)
 The following is a high level description of a radix-3 adder
 Input: $a, b \in \{0,1,2\}$
 Output: s (sum) and c (carry) as defined in the table below

a	0	0	0	1	1	1	2	2	2
b	0	1	2	0	1	2	0	1	2
s	0	1	2	1	2	0	2	0	1
c	0	0	0	0	0	1	0	1	1

Give the binary level specification of this adder.

4. (3 points)

Below is a block diagram of a 4-bit counter. It has two control signals Load and Count. When Load = 1, the counter loads its content from inputs D_i (i.e., $Q_i = D_i$); when Count = 1 and Load = 0, it counts up; when Count = 0 and Load = 0, no change happens. Both “load” and “count” occur at the positive edge of the clock pulse (CP). The Carry Out signal (CO) is 1 if and only if the counter is in “count” mode and has content 1111.

Use this 4-bit counter to construct a 1-to-12 counter that counts up from 1 to 12 and returns to 1. You can draw on the diagram below and use logic gates if necessary.

