EECE 238 Exam II Regular

Name: Solutions

Problem 1	25 /25
Problem 2	25 /25
Problem 3	30 /30
Problem 4	20 /20
Total:	100/100

Good Luck!

Problem 1 (25 points total) *Counter with Parallel Load*

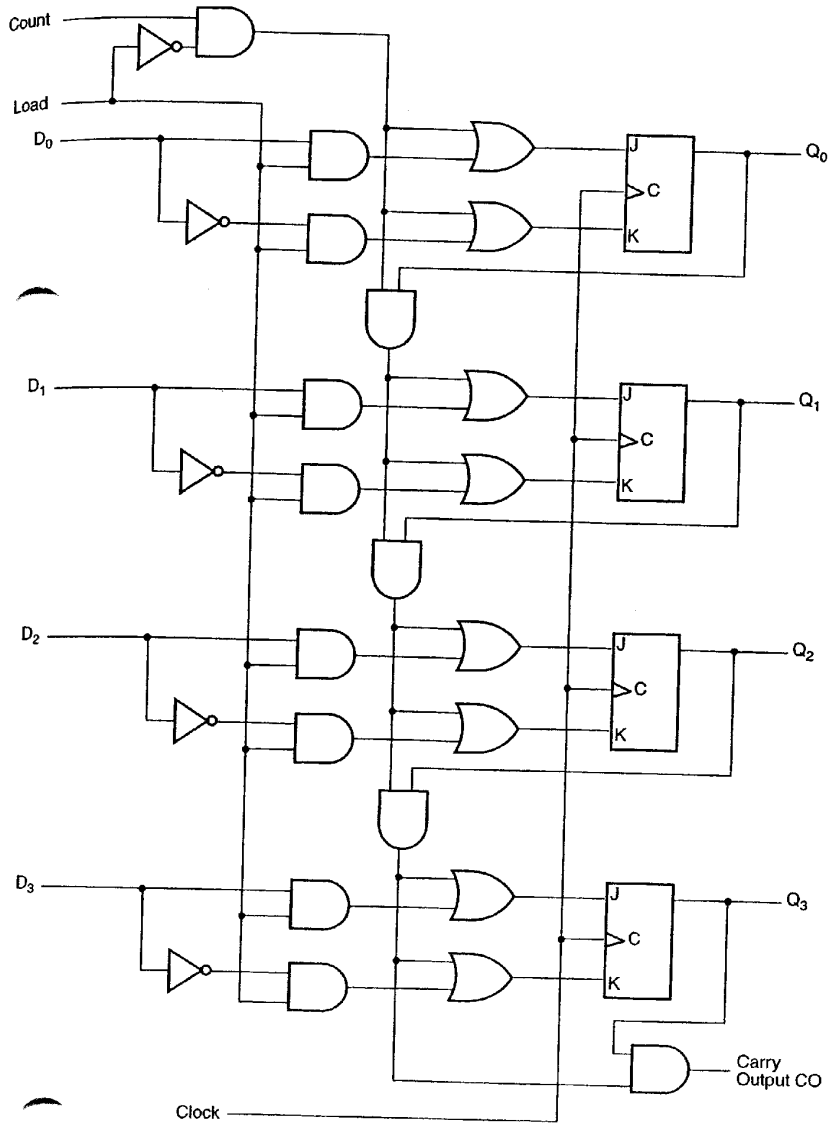
The digital logic circuit below represents a 4-Bit Binary Counter with Parallel Load. Assume that originally, all the 0 Flip-Flops store 0: [redacted]

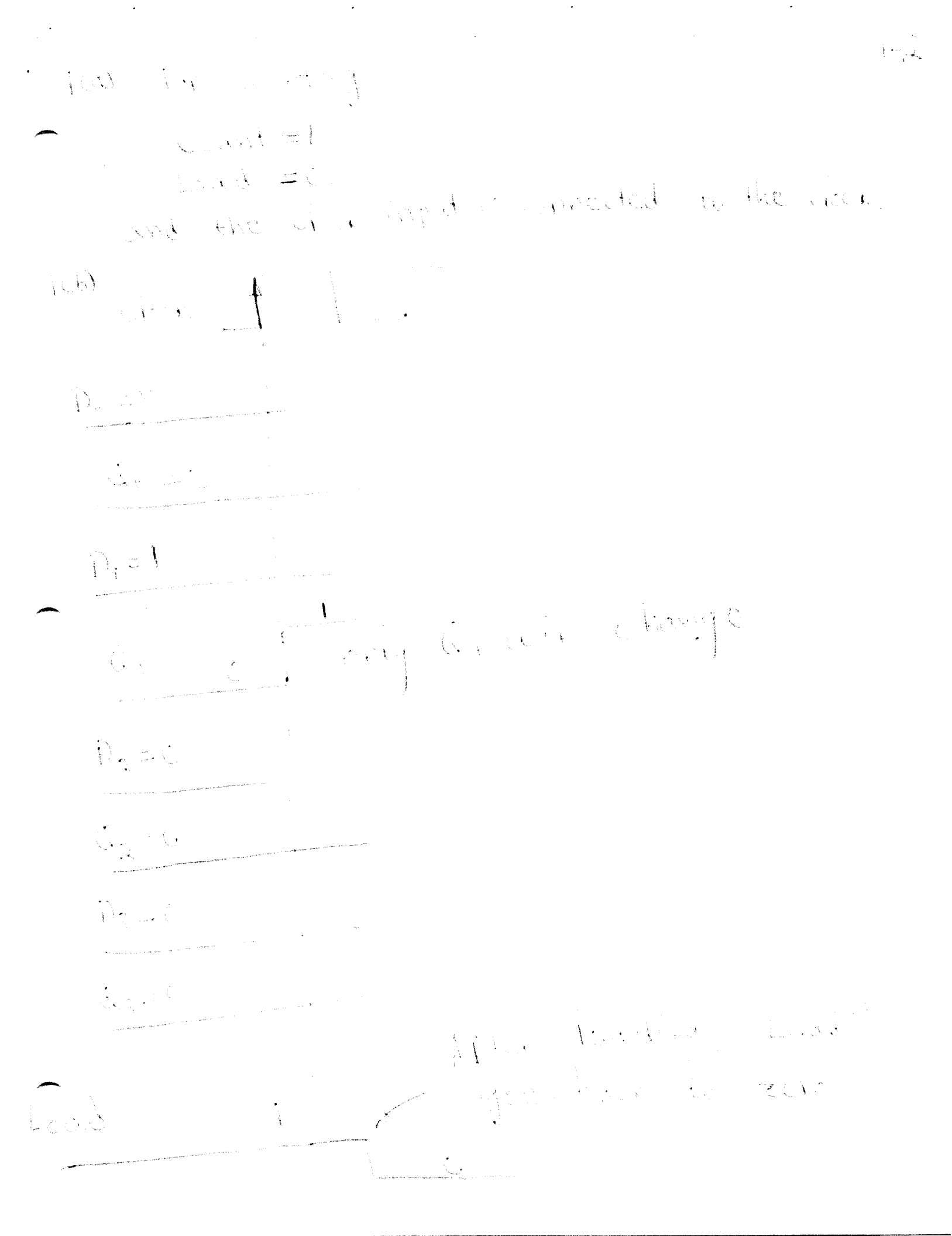
1(a) (5 points) Indicate how to make the counter count. How should you connect the inputs?

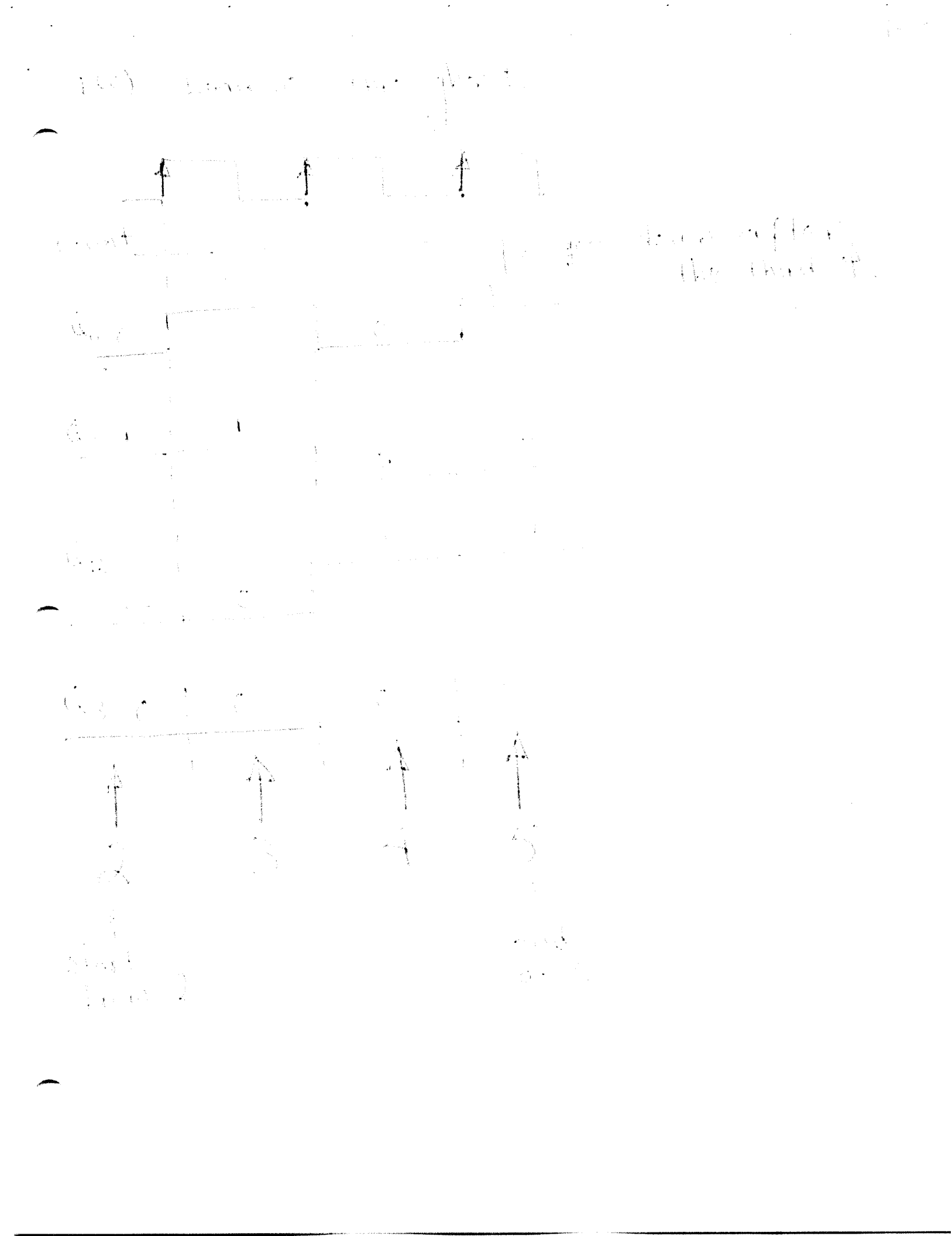
The following steps are used to make the counter count from 2 to 5. ***For full-credit in parts 1(b) and 1(c),, you must show the clock input, all the affected inputs (possible inputs are:*** D_0, D_1, D_2, D_3, Load, and Count***), and all the outputs:*** Q_0, Q_1, Q_2, Q_3.

1(b) (5 points) Indicate how to load 2 into the counter.

1(c) (15 points) Show how to make the counter count to 5, and **then stop**.



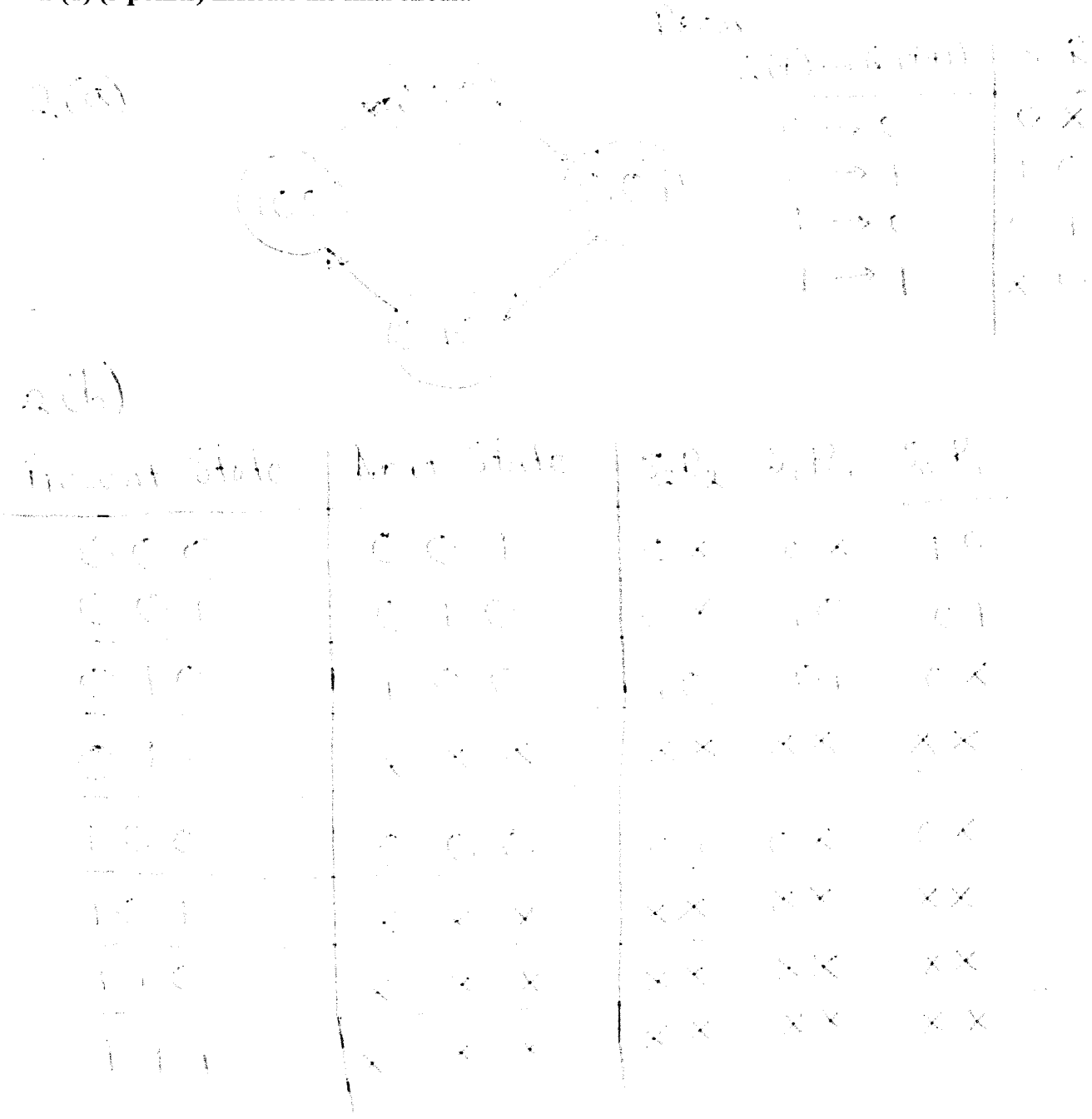


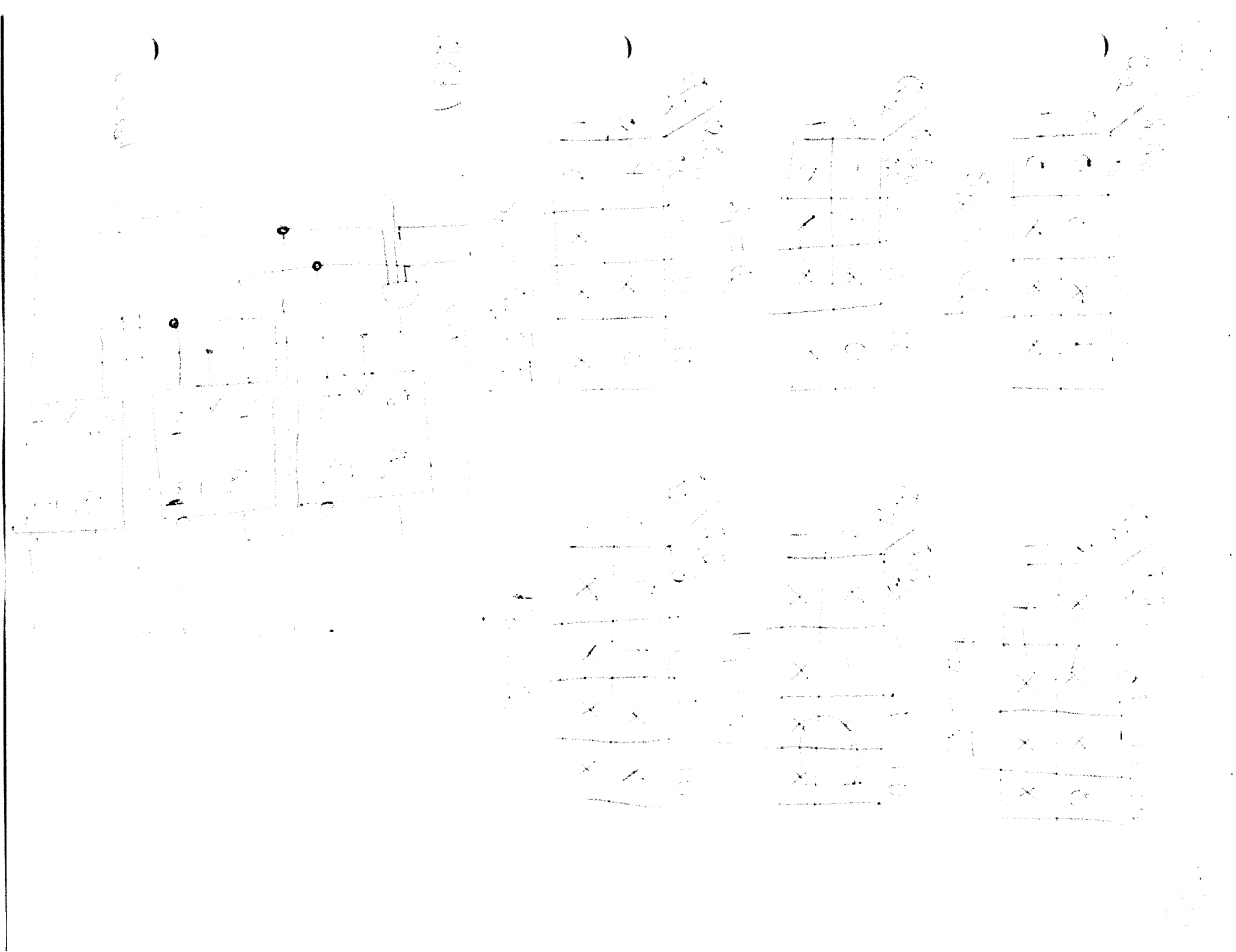


Problem 2 (25 points total) *Synchronous Counter Design.*

Design a binary counter that counts through the 3-bit binary numbers: 000, 001, 010, 100, and then repeat from 000. For your design, assume that **there is** a reset signal that will force counting to start at 000. Assume that the states codes are assigned unsigned integer representations.

2 (a) (5 points) Draw the state transition diagram.
2 (b) (10 points) Derive the state table for implementing the counter using S-R Flip-Flops.
2 (c) (5 points) Use K-maps to minimize the inputs to the S-R Flip-Flops.
2 (d) (5 points) Indicate the final circuit.



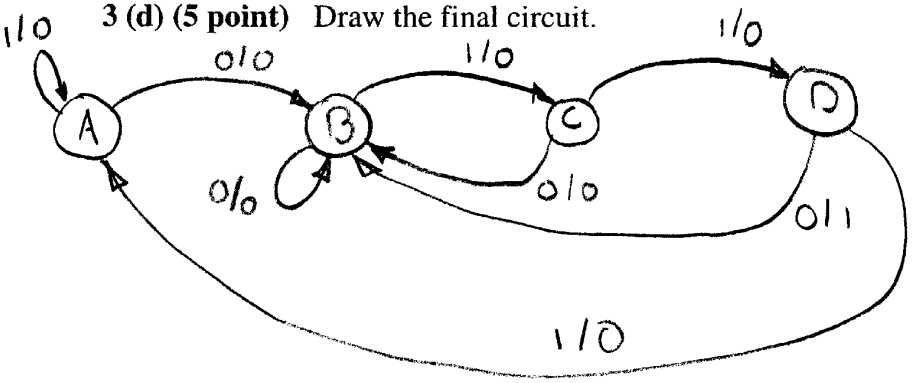


Problem 3 (20 points total) Sequential Circuit Design

Design a digital circuit to recognize the occurrence of the input sequence 0110. The circuit will output a 1 when the previous inputs were 011 and the current input is 0. Note that since the output depends on the input (as well as the current state), you need a ***Mealy*** solution to this problem.

3 (a) (5 points) Derive the state transition diagram.
3 (b) (5 points) Derive the state table and Flip-Flop inputs for J-K Flip-Flops.
3 (c) (5 points) Use Karnaugh maps to minimize the equations for the Flip-Flop inputs, and the output.
3 (d) (5 point) Draw the final circuit.

3(a)



A: no "0" yet
B: "0" received
C: "01" received
D: "011" received

3(b)

Present State	Next State I=0	Next State I=1	J_1K_1 I=0	J_0K_0 I=0	J_1K_1 I=1	J_0K_0 I=1	Out I=0	Out I=1
A: 00	B: 01	A: 00	0 X	1 X	0 X	0 X	0	0
B: 01	B: 01	C: 11	0 X	X 0	1 X	X 0	0	0
C: 11	B: 01	D: 10	X 1	X 0	X 0	X 1	0	0
D: 10	B: 01	A: 00	X 1	1 X	X 1	0 X	1	0

Q(t)	Q(t+1)	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

3(c)

Q_1Q_0 \ I

	0	1
00	0	0
01	0	0
11	X	X
10	X	X

$J_1 = Q_0 I$

Q_1Q_0 \ I

	0	1
00	X	X
01	X	X
11	1	0
10	1	1

$K_1 = I + Q_0'$

Q_1Q_0 \ I

	0	1
00	1	0
01	X	X
11	X	X
10	1	0

$J_0 = I'$

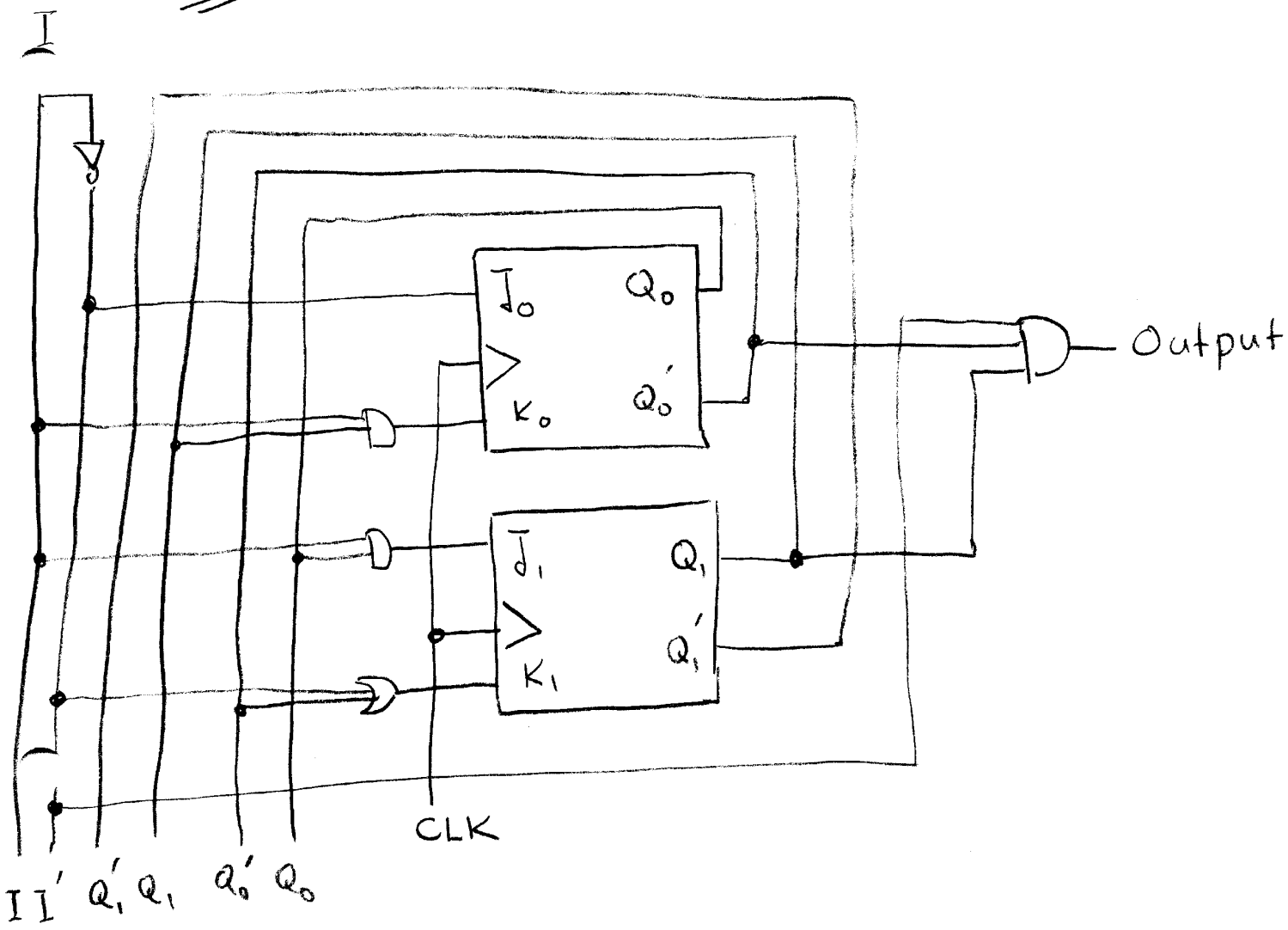
Q_1Q_0 \ I

	0	1
00	X	X
01	0	0
11	0	0
10	X	X

$K_0 = I Q_1$

$Output = I' Q_1 Q_0'$

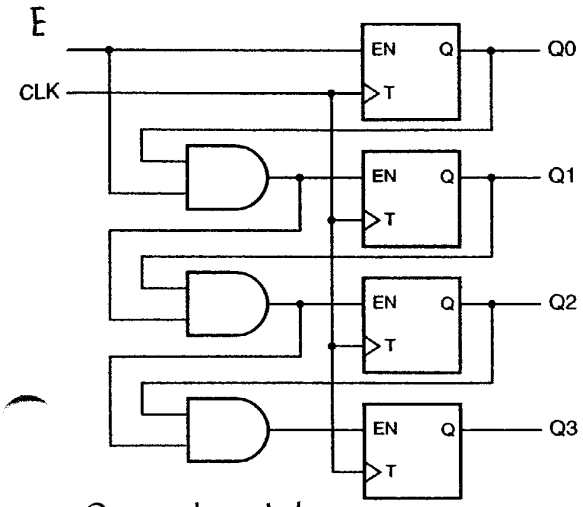
3(d)



Problem 4 (20 points total) *Sequential Circuit Analysis*

Consider the sequential circuit given below. We would like to analyze the circuit and understand what it does.

4 (a) (5 points) Derive the T flip-flop input equations.
4 (b) (5 points) Derive the next-state table based on 3(a).
4 (c) (5 points) Derive the state-diagram based on the next-state table.
4 (d) (5 points) What does this circuit do?



4(a)

$Q_{0,EN} = E$

$Q_{1,EN} = EQ_0$

$Q_{2,EN} = EQ_0Q_1$

$Q_{3,EN} = EQ_0Q_1Q_2$

table for E = 1

4(b)

Present state $Q_3Q_2Q_1Q_0$	$Q_{3,EN}$	$Q_{2,EN}$	$Q_{1,EN}$	$Q_{0,EN}$	Next state $Q_3^+Q_2^+Q_1^+Q_0^+$
0 0 0 0	0	0	0	1	0 0 0 1
0 0 0 1	0	0	1	1	0 0 1 0
0 0 1 0	0	0	0	1	0 0 1 1
0 0 1 1	0	1	1	1	0 1 0 0
0 1 0 0	0	0	0	1	0 1 0 1
0 1 0 1	0	0	1	1	0 1 1 0
0 1 1 0	0	0	0	1	0 1 1 1
0 1 1 1	1	1	1	1	1 0 0 0
1 0 0 0	0	0	0	1	1 0 0 1
1 0 0 1	0	0	1	1	1 0 1 0
1 0 1 0	0	0	0	1	1 0 1 1
1 0 1 1	0	1	1	1	1 1 0 0
1 1 0 0	0	0	0	1	1 1 0 1
1 1 0 1	0	0	1	1	1 1 1 0
1 1 1 0	0	0	0	1	1 1 1 1
1 1 1 1	1	1	1	1	0 0 0 0

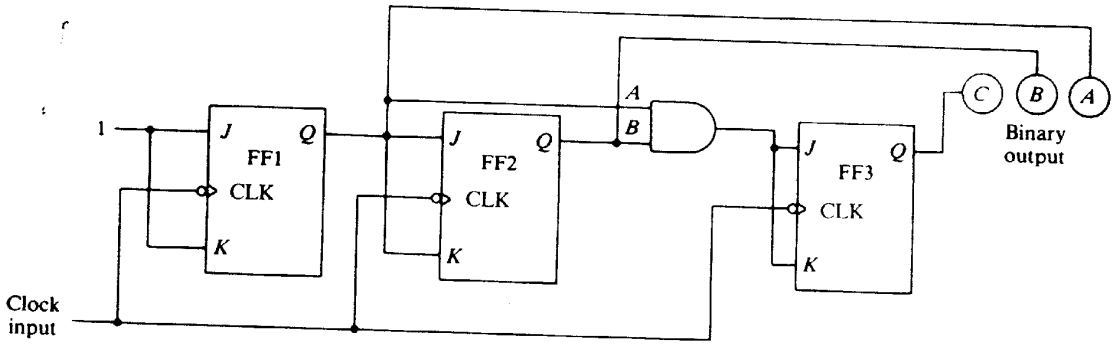
4(c)

4(d) When I = 1, the circuit counts from 0 to 15 and then back from 0 to 15.

Problem 3 (30 points total) *Sequential Circuit Analysis*

Consider the sequential circuit given below. We would like to analyze the circuit and understand what it does.

3(a) (5 points) Derive the J-K flip-flop input equations.
3(b) (15 points) Derive the next-state table based on 3(a).
3(c) (5 points) Derive the state-diagram based on the next-state table.
3(d) (5 points) What does this circuit do?



Problem 4 (20 points total) *Sequential Circuit Analysis*

Consider the sequential circuit given below. We would like to analyze the circuit and understand what it does.

4 (a) (5 points) Derive the T flip-flop input equations.
4 (b) (5 points) Derive the next-state table based on (a).
4 (c) (5 points) Derive the state-diagram based on the next-state table.
4 (d) (5 points) What does this circuit do?