ECE 218 Digital Systems

Lab Final Exam

2021 Spring
Electrical and Computer Engineering Department
Illinois Institute of Technology

	First Name	Last Name
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- This examination is an open book and open note exam.
- Discussion and Cell phones are not allowed.
- You will have 150 mins to complete this exam individually (8:10am — 10:40am).
- Part 1 (Written Test: Question 1 - 4) will be collected around 10:30am.
- Part 2 (Experiment Test: Question 5) need to be demonstrated to TA before 10:40am.
- Write your name and CWID on this page and on the top of each successive pages.
- Good Luck!

Design a 3-bit Gray code counter with enable input EN, using D Flip-Flops and combinational logic gates. When EN is logic H, the counter should go through the counting sequence of a Gray code; When EN is logic L, the counter stays in the current state.

Question 1: Draw the state diagram. (20 points)

Question 2: Draw the state transition table. (20 points)

Question 3: Derive the equations for output literals D_A, D_B, and D_C in terms of input literals EN, Q_A, Q_B, and Q_C using K-map. (20 points)

Question 4: Design the 3-bit Gray code counter with enable using D flop-flops and combinational logic gates. Draw the schematic. (20 points)

Question 5: Realize the 3-bit Gray code counter with enable on the breadboard. Input EN controlled by a switch in an input circuit. Outputs D_A, D_B, and D_C connects to three output circuits and show the results with LEDs. (20 points)

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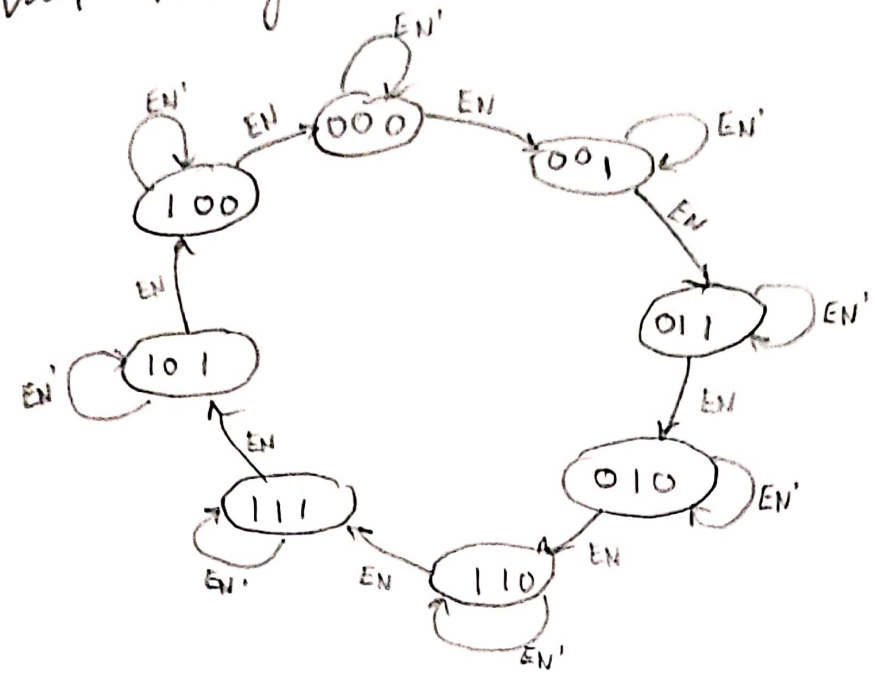
Q.1)



State Diagram

Q.2)

Present State			Next State						D Flip-Flop					
			EN=1			EN=0			EN=1			EN=0		
Q_A	Q_B	Q_C	q_A	q_B	q_C	q_A	q_B	q_C	D_A	D_B	D_C	D_A	D_B	D_C
0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
0	0	1	0	1	1	0	0	1	0	1	1	0	0	1
0	1	1	0	1	0	0	1	1	0	1	0	0	1	1
0	1	0	1	1	0	0	1	0	1	1	0	0	1	0
1	1	0	1	1	1	1	1	0	1	1	1	1	1	0
1	1	1	1	0	1	1	1	1	1	0	1	1	1	1
1	0	1	1	0	0	1	0	1	1	0	0	1	0	1
1	0	0	0	0	0	1	0	0	0	0	0	1	0	0

Transition Table

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Q.3)

D_A

$q_A q_B$ \ $q_n EN$	00	01	11	10
00	0	0	0	0
01	0	1	0	0
11	1	1	1	1
10	1	0	1	1

$$D_A = Q_B Q_C' E_n + Q_B E_n' + Q_n Q_C$$

D_C

$q_B q_C$ \ $q_n E_n$	00	01	11	10
00	0	1	1	1
01	0	0	0	1
11	0	1	1	1
10	0	0	0	1

$$D_C = Q_n' Q_B' E_n + Q_n Q_C E_n + Q_C E_n'$$

D_B

$q_B q_C$ \ $q_n EN$	00	01	11	10
00	0	0	1	0
01	1	1	1	1
11	1	1	0	1
10	0	0	0	0

$$D_B = Q_B E_n' + Q_B Q_C' + Q_n' Q_C E_n$$

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Q4)