Homework 3

● Graded

Student

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Total Points

96 / 100 pts

Question 1

Overview

0 / 0 pts

✔ **+ 0 pts** Correct

+ 0 pts Incorrect

Question 2

Boolean Expression to Circuit

7 / 7 pts

✔ **+ 7 pts** Correct (D)

+ 7 pts Correct

+ 0 pts Incorrect

Question 3

K-Maps **20** / 24 pts

3.1 **Truth Table to K-Map** **4** / 8 pts

+ 0 pts Missing zeros

+ 8 pts Correct (logical equivalent of examples):

	AB	AB'	A'B'	A'B
C	0	0	0	1
C'	1	1	1	X

	A'B'	A'B	AB	AB'
C'	1	X	1	1
C	0	1	0	0

+ 7 pts Correct KMap, but not handwritten

✔ **+ 4 pts** Partially correct - minor mistake:
(1) Error in grey code, but otherwise correct placement of 1s, 0s, and Xs
(2) Incorrect placement of one or two of the 1s and X
~~(3) Did not fill in zeros on the kmap~~

+ 0 pts Incorrect -
(1) Incorrect gray code AND incorrect placement of 1 or more 1s, 0s, and Xs
(2) 3+ incorrect placements of 1s,0s, and X's

Error in grey code -- BC and B'C' differ by 2 bits

3.2 **K-Map Grouping 1** **8** / 8 pts

✔ **+ 8 pts** Correct (B+C')

+ 4 pts Minor mistake:
(1) did one group of 4 and one group of 2 (ex. B+BC or B+B'C', instead of B+C') - forgot to overlap groups

+ 0 pts Incorrect, contains one of the following:
(1) 2 Incorrect terms
(2) More than 2 terms in expression
(3) Incomplete or incorrect expression

+ 0 pts Incorrect

+ 8 pts Correct

3.3 **K-Map Grouping 2** **8** / 8 pts

✔ **+ 8 pts** Correct (BD+CD' - two groups of 4)

+ 8 pts Correct

+ 0 pts Incorrect

+ 4 pts Partially correct - minor mistake:
(1) Incorrect groupings - 2 groups of 2 and one group of 4 (ex. CD' + BC'D + BCD or logical equivalent expression with 3 terms)

+ 0 pts Incorrect, contains one of the following:
(1) more than 3 terms in expression
(2) incorrect terms
(3) incomplete or incorrect expression

Question 4

Gated D-Latch **14** / 14 pts

4.1 **Truth Table 1** **7** / 7 pts

✔ **+ 7 pts** Correct:
(a) 0
(b) 1
(c) 0
(d) 0

+ 7 pts Correct

+ 5.25 pts 3 out of 4 correct

+ 3.5 pts 2 out of 4 correct

+ 1.75 pts 1 out of 4 correct

+ 0 pts Incorrect

4.2 **Truth Table 2** **7** / 7 pts

✔ **+ 7 pts** Correct:
(a) 1
(b) 1
(c) 1
(d) 0

+ 7 pts Correct

+ 5.25 pts 3 out of 4 correct

+ 3.5 pts 2 out of 4 correct

+ 1.75 pts 1 out of 4 correct

+ 0 pts Incorrect

Question 5

Sequential Logic & Memory **16** / 16 pts

5.1 **(no title)** **4** / 4 pts

✔ **+ 4 pts** Correct (256)

+ 4 pts Correct

+ 0 pts Incorrect

5.2 **(no title)** **4** / 4 pts

✔ **+ 4 pts** Correct (256)

+ 4 pts Correct

+ 0 pts Put the answer: 8

+ 0 pts Incorrect

5.3 **(no title)** **4** / 4 pts

✔ **+ 4 pts** Correct (8)

+ 4 pts Correct

+ 0 pts Incorrect

5.4 **(no title)** **4** / 4 pts

✔ **+ 4 pts** Correct (4)

+ 4 pts Correct

+ 0 pts Incorrect

Question 6

Multi-Step State Machine Minimization **30** / 30 pts

6.1 **State Diagram to Truth Table** **15** / 15 pts

✔ **+ 15 pts** Correct (8 out of 8 rows):
(a) 0 0
(b) 0 1
(c) 0 0
(d) 1 0
(e) 0 0
(f) 1 1
(g) 0 0
(h) 1 1

+ 15 pts Correct

+ 13.125 pts 7 out of 8 rows correct

+ 11.25 pts 6 out of 8 rows correct

+ 9.375 pts 5 out of 8 rows correct

+ 7.5 pts 4 out of 8 rows correct OR every row is swapped

+ 5.625 pts 3 out of 8 rows correct

+ 3.75 pts 2 out of 8 rows correct

+ 1.875 pts 1 out of 8 rows correct

+ 0 pts Incorrect

6.2 **Truth Table to KMap** **10** / 10 pts

✔ **+ 10 pts** Correct:
(row t) 0 0 0 0
(row u) 0 1 1 1
(row v) 0 0 0 0
(row w) 1 0 1 1

+ 10 pts Correct

+ 7.5 pts 3 out of 4 rows correct

+ 5 pts 2 out of 4 rows correct

+ 2.5 pts 1 out of 4 rows correct

+ 0 pts Incorrect

6.3 **KMap to Simplified Expression** **5** / 5 pts

✔ **+ 5 pts** Correct:
N1 = S0p+S1p
N0 = S0'p+S1p

+ 3.75 pts Partial credit - does ONE of the following:
(1) 1 expression COMPLETELY correct (fully simplified), 1 expression with MINOR mistake (see below)

+ 2.5 pts Partial credit - does ONE of the following:
(1) 1 expression completely correct, 1 expression completely incorrect (major mistake/not logically equiv.)
(2) TWO MINOR mistakes (both expressions - see below)

EXAMPLES OF MINOR MISTAKE:
N1 = S0p+S1S0'p
N1 = S1p+S1'S0p
N0 = S0'S1'p+S1p
N0 = S0'p+S1S0p

+ 1.25 pts Partial Credit - does one of the following:
(1) One expression COMPLETELY incorrect AND MINOR mistake in other expression (see above)
(2) Uses p' for all expressions instead of p, but otherwise correct

+ 0 pts Incorrect

Question 7

Edge vs. Level Triggered Logic **9** / 9 pts

7.1 **(no title)** **3** / 3 pts

✔ **+ 3 pts** Correct (edge)

+ 3 pts Correct

+ 0 pts Incorrect

7.2 **(no title)** **3** / 3 pts

✔ **+ 3 pts** Correct

+ 0 pts Incorrect

7.3 **(no title)** **3** / 3 pts

✔ **+ 3 pts** Correct

+ 0 pts Incorrect

Q1 Overview

0 Points

This homework is worth a total of 100 points.

This question (`Q1`) cannot be answered. It's used for formatting instructions. Do not worry about Gradescope saying you haven't answered one question. It's this one!

Try not to use calculators or any other computer aides in working these problems, except to double-check your responses. Why? The exam will not allow calculators.

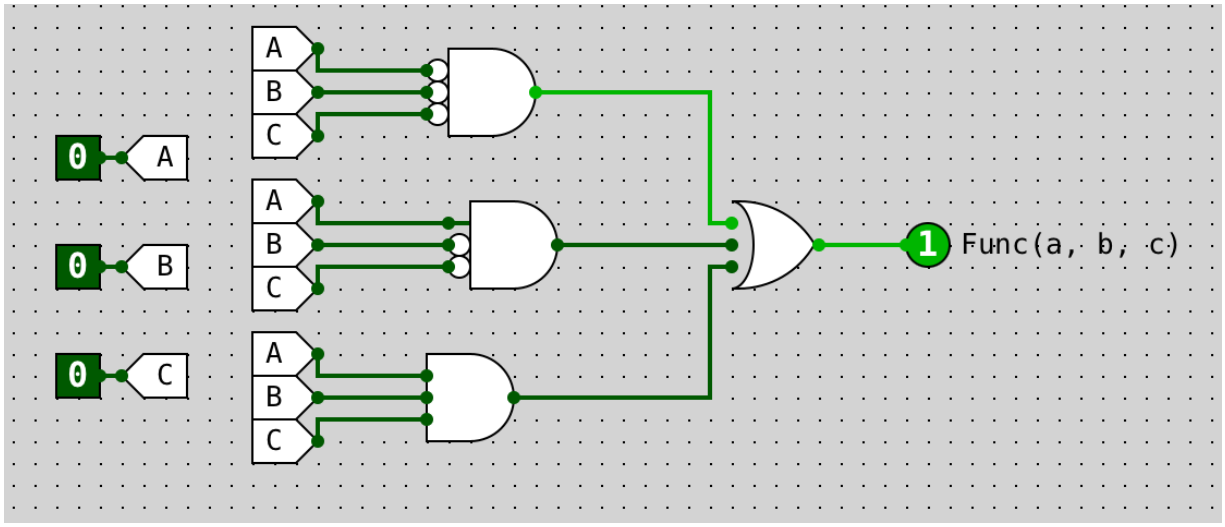
Please complete the following problems. The collaboration policy for the course still applies. Refer to the syllabus for details regarding this policy.

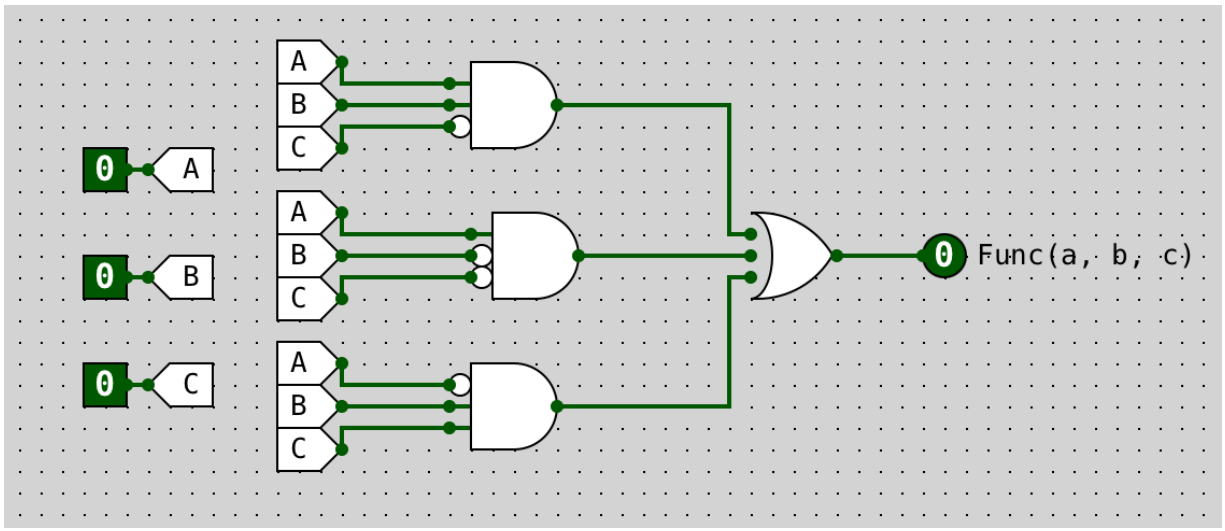
Q2 Boolean Expression to Circuit

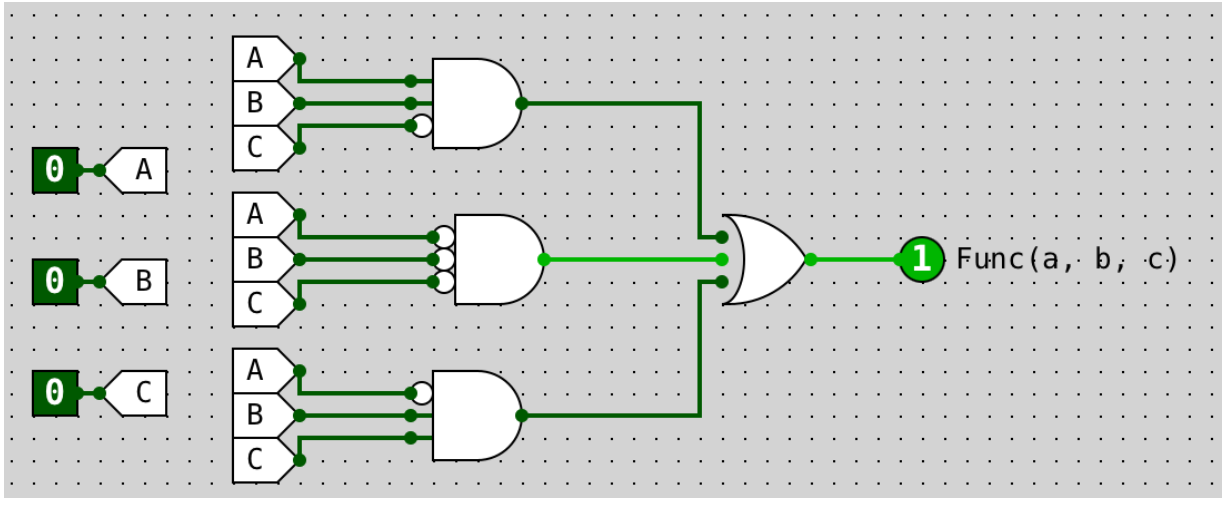
7 Points

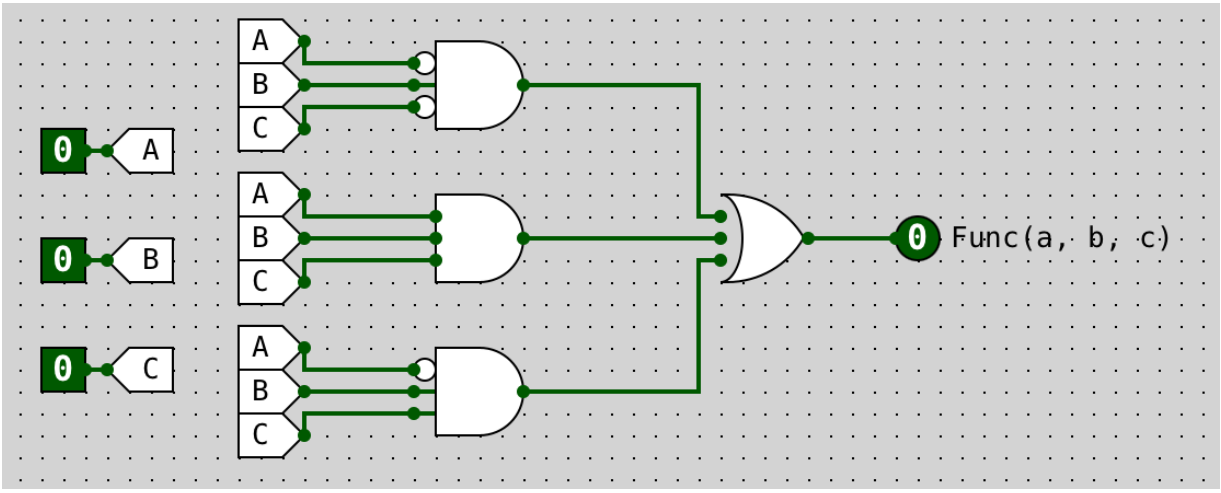
Which one of the circuits below correctly represent the following boolean expression? That is, for all inputs `A`, `B`, and `C` in the circuit, it leads to the same output as the boolean expression given the same inputs.

`Func(A,B,C) = A'BC + A'BC' + ABC`








A
B
C
0
A
A
B
C
0
B
A
B
C
0
C
0
Func(a, b, c)

Q3 K-Maps

24 Points

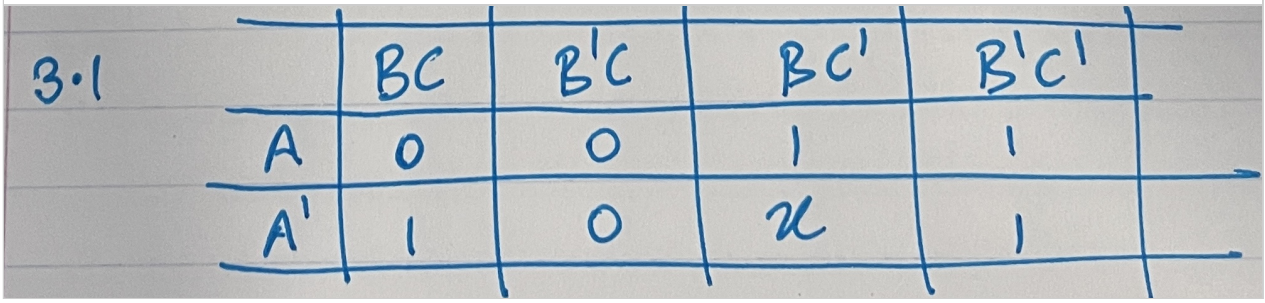
Q3.1 Truth Table to K-Map
8 Points

Given the following truth table, convert the table into a K-Map and upload your KMap below.

A	B	C	OUT
0	0	0	1
0	0	1	0
0	1	0	X
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

Upload a clear photo of a *handwritten* KMap representing the above truth table.

IMG_4706.jpg Download



Q3.2 K-Map Grouping 1
8 Points

Generate the **most simplified** sum-of-products expression possible, using the K-Map provided below.

	AB	AB'	A'B'	A'B
C'	1	1	1	X
C	1	0	0	1

FORMATTING NOTES:

- use a single quote (`'`) to represent the complement of a variable
- only use the variables `A`, `B`, and `C` (case-sensitive)
- format `AND` by concatenating the relevant variables without any spaces or symbols in between (e.g. `AB`)
- when using `AND` with multiple variables, place `A` first, `B` second, and `C` third (e.g. `ABC`, `AC`, `BC`)
- format `OR` with only a plus (`+`) sign and NO spaces between any two relevant sets of variables (e.g. `A+B'C`)

B+C'

Q3.3 K-Map Grouping 2
8 Points

Generate the **most simplified** sum-of-products expression possible, using the K-Map provided below.

	AB	AB’	A’B’	A’B
CD	X	0	0	1
CD’	X	1	1	1
C’D’	0	0	0	0
C’D	1	0	0	1

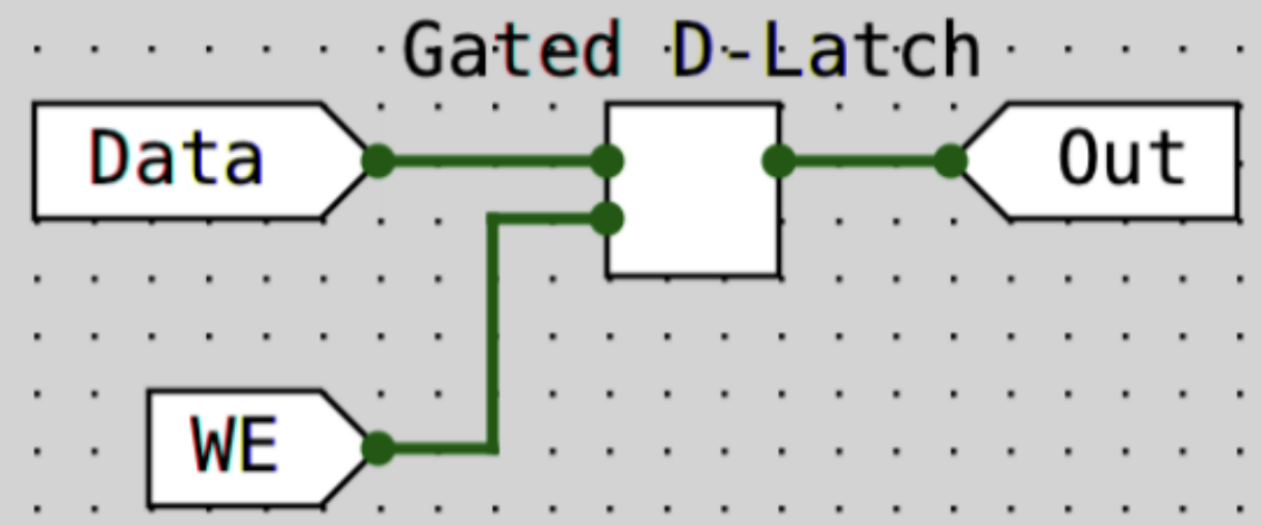
FORMATTING NOTES:

- use a single quote (`'`) to represent the complement of a variable
- only use the variables `A`, `B`, `C`, and `D` (case-sensitive)
- format `AND` by concatenating the relevant variables without any spaces or symbols in between (e.g. `AB`)
- when using `AND` with multiple variables, place `A` first, `B` second, and `C` third (e.g. `ABC`, `AC`, `BC`)
- format `OR` with only a plus (`+`) sign and NO spaces between any two relevant sets of variables (e.g. `A+B'C`)

BD+CD'

Q4 Gated D-Latch

14 Points



Fill in the blanks in the Truth Tables given below according to the Gated D-Latch circuit provided above.

Q4.1 Truth Table 1
7 Points

Time	Data	WE	Out
0	1	0	(a)
1	1	1	(b)
2	0	1	(c)
3	1	0	(d)

Assume the Gated D-Latch is **storing a value of 0** before the cycles begin.

(a)

0

(b)

1

(c)

0

(d)

0

Q4.2 Truth Table 2
7 Points

Time	D	WE	Out
0	0	0	(a)
1	1	1	(b)
2	1	0	(c)
3	0	1	(d)

Assume the Gated D-Latch is **storing a value of 1** before the cycles begin.

(a)

1

(b)

1

(c)

1

(d)

0

Q5 Sequential Logic & Memory

16 Points

Q5.1

4 Points

A given computer has a 2-byte **addressability** and uses 4 bits to represent a memory address. What is the total size of this computer's memory **in bits**?

256

Q5.2

4 Points

Memory addresses on a given computer are **1 byte** wide, and there is an **16 bit** value stored at each address. What is this computer's address space?

256

Q5.3

4 Points

A given computer stores 64-bit values at each of its 1024 memory locations. What is this computer's addressability **in bytes**?

8

Q5.4

4 Points

How many **bits** would a memory/register component require to represent the 9 distinct states of a given binary-encoded state machine?

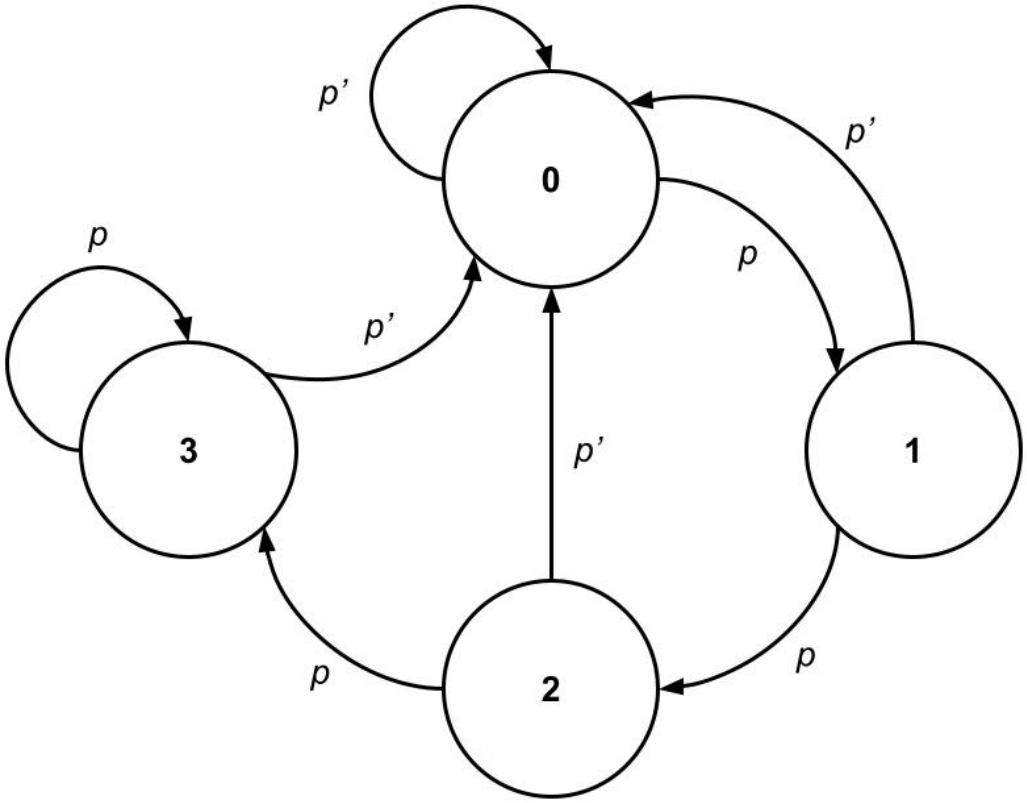
4

Q6 Multi-Step State Machine Minimization

30 Points

Q6.1 State Diagram to Truth Table
15 Points

Complete the following truth table according to the given **binary-encoded** state machine diagram.



Note that...

- S0 and S1 entries represent the current state's bit 0 and bit 1, respectively.
- N0 and N1 entries represent the next state's bit 0 and bit 1, respectively.

ex. if `S = 10`*, then* `S1 = 1` *and* `S0 = 0`

S1	S0	p	N1	N0
0	0	0	(a0)	(a1)
0	0	1	(b0)	(b1)
0	1	0	(c0)	(c1)
0	1	1	(d0)	(d1)
1	0	0	(e0)	(e1)
1	0	1	(f0)	(f1)
1	1	0	(g0)	(g1)
1	1	1	(h0)	(h1)

IMPORTANT FORMATTING NOTE: Each short answer entry below corresponds to **one row** from the above truth table. Enter your answer in each box as **2 characters** (from 0, 1, or X) with **one space in between**.

Example: a row (z)'s answer box could be filled out as `0 1` with the `0` representing (z0) and `1` representing (z1) boxes from the truth table, respectively.

row (a) =

0 0

row (b) =

0 1

row (c) =

0 0

row (d) =

1 0

row (e) =

0 0

row (f) =

1 1

row (g) =

0 0

row (h) =

1 1

Q6.2 Truth Table to KMap
10 Points

Fill in the following K-maps according to your truth table from Q6.1.

N1 K-Map

	S1'S0'	S1'S0	S1S0	S1S0'
p'	(t0)	(t1)	(t2)	(t3)
p	(u0)	(u1)	(u2)	(u3)

N0 K-Map

	S1'S0'	S1'S0	S1S0	S1S0'
p'	(v0)	(v1)	(v2)	(v3)
p	(w0)	(w1)	(w2)	(w3)

IMPORTANT FORMATTING NOTE: Each short answer entry below corresponds to **one row** from the above K-Maps. Enter your answer in each box as **4 characters** (from 0, 1, or X) with **one space between each character**.

Example: a row (y)'s answer box could be filled out as `0 1 X X` with each character representing the (y0), (y1), (y2) and (y3) boxes from the K-Map, respectively.

row (t) =

0 0 0 0

row (u) =

0 1 1 1

row (v) =

0 0 0 0

row (w) =

1 0 1 1

Q6.3 KMap to Simplified Expression
5 Points

Using the K-Maps you produced in Q6.2, write the **fully** simplified sum of products expressions for each K-Map in the short answer boxes below.

IMPORTANT FORMATTING NOTES:

- use a single quote (`'`) to represent the complement of a variable
- only use the variables `S0`, `S1`, and `p` (case-sensitive)
- format `AND` by concatenating the relevant variables without any spaces or symbols in between (e.g. `S0S1p`)
- when using `AND` with multiple variables, place `S0` first, `S1` second, and `p` third (e.g. `S0S1p`, `S0p`, `S1p`)
- format `OR` with only a plus (`+`) sign and NO spaces between any two relevant sets of variables (e.g. `S0+S1p`)

N1 =

S0p+S1p

N0 =

S0'p+S1p

Q7 Edge vs. Level Triggered Logic
9 Points

Q7.1
3 Points

A logic component whose value is updated when the clock changes from high to low **OR** low to high follows ____-triggered logic.

edge

Q7.2
3 Points

You are presented a logic component that has **2 input ports** (`X`, `Y`) and **1 output port** (`O`). This logic component's output value (`O`) is updated to match input port `X` *only when port* `Y` *is* ***high***.

Based on the size of the component, you know that it is composed of an RS-latch and a few more gates. What is the name of this logic component?

- ○ D Flip-Flop
- ◉ Gated D-Latch

Q7.3
3 Points

Which sequential logic component should be used to build a register, given that registers are **edge-triggered**?

- ○ Decoder
- ◉ D Flip-Flop
- ○ RS Latch
- ○ Multiplexer
- ○ Gated D-Latch