

# Homework 3

● Graded

## Student

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## Total Points

100 / 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

24 / 24 pts

3.1 **Truth Table to K-Map**

8 / 8 pts

**+ 0 pts** Missing zeros**✓ + 8 pts** Correct (logical equivalent of examples):

	<b>AB</b>	<b>AB'</b>	<b>A'B'</b>	<b>A'B</b>
<b>C</b>	0	0	0	1
<b>C'</b>	1	1	1	X

	<b>A'B'</b>	<b>A'B</b>	<b>AB</b>	<b>AB'</b>
<b>C'</b>	1	X	1	1
<b>C</b>	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

 I respect you for filling the whole page with this

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.

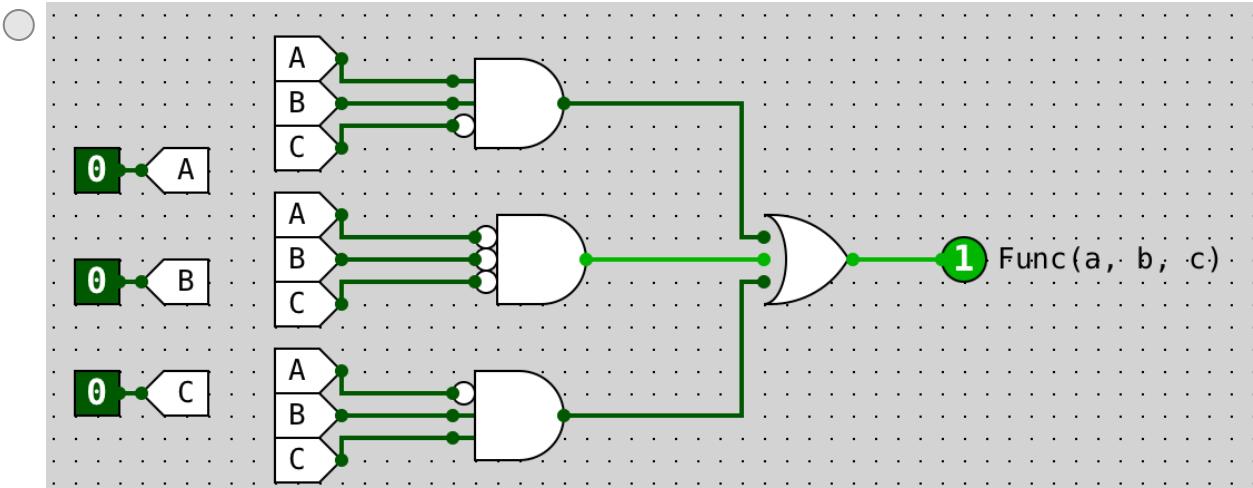
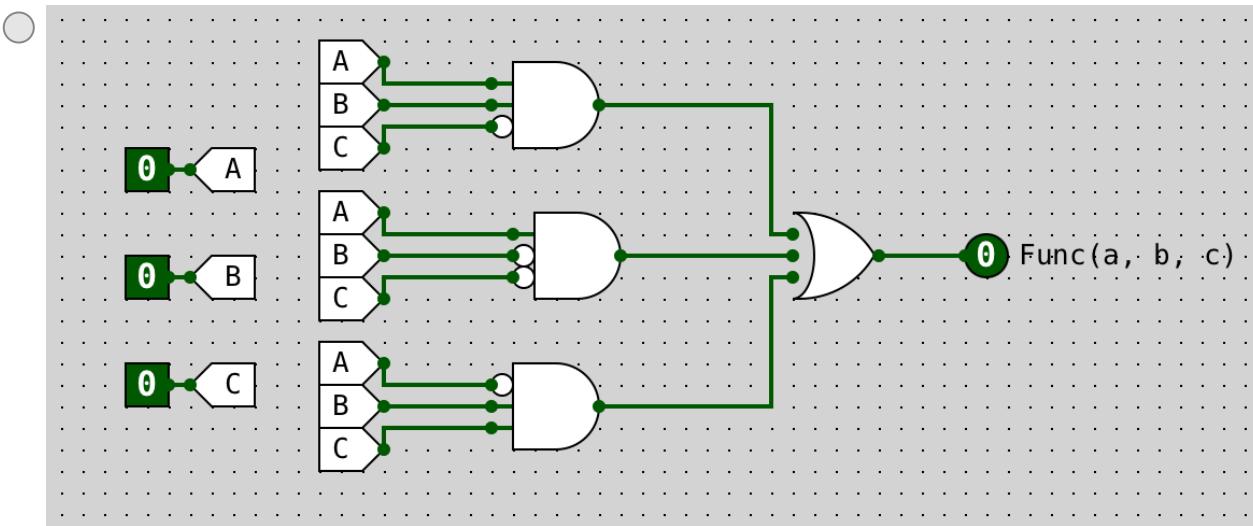
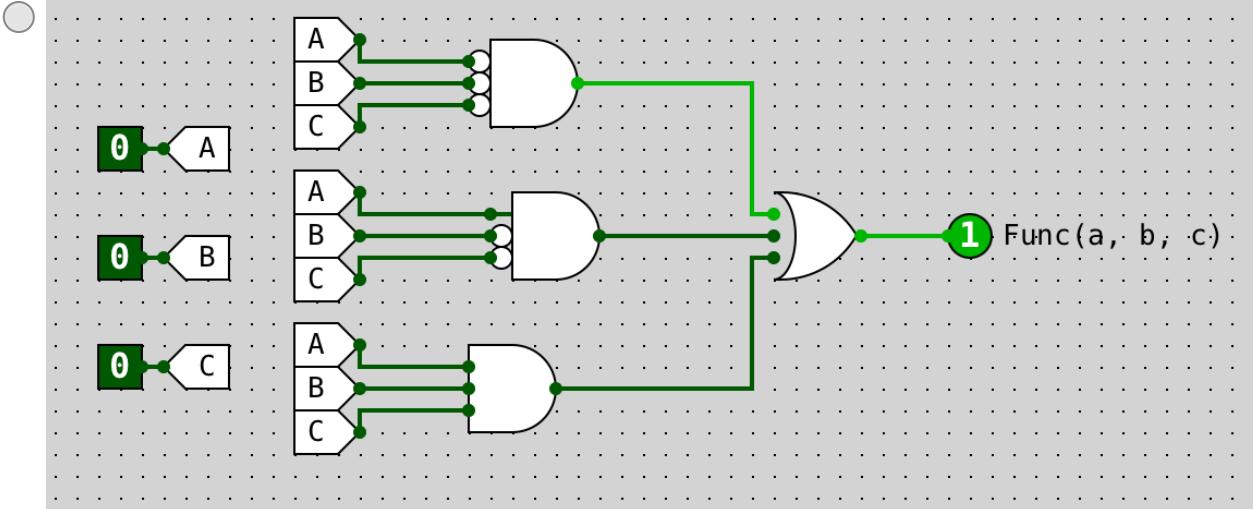
Please complete the following problems. The collaboration policy for the course still applies. Refer to the syllabus for details regarding this policy.

## Q2 Boolean Expression to Circuit

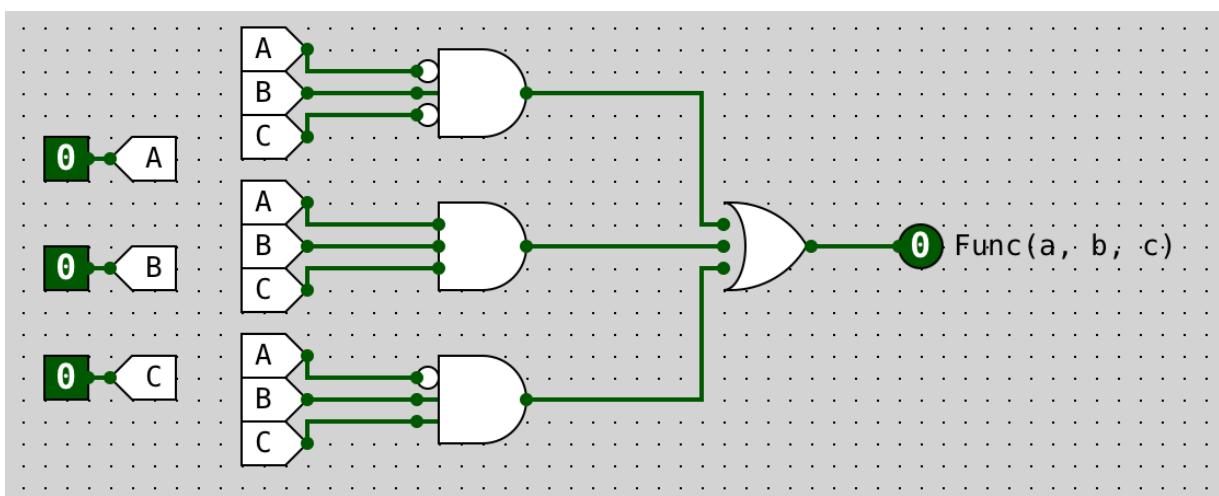
7 Points

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.

$$\text{Func}(A, B, C) = A'BC + A'BC' + ABC$$



Q



**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.

## Question 31

	BC	BC'	B'C'	B'C
A	0 ABC	1 A'B'C'	1 A'B'G'	0 A'B'F
A'	1 A'B'C	X A'B'C'	1 A'B'C'	0 A'B'C

### Q3.2 K-Map Grouping 1

8 Points

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

	<b>AB</b>	<b>AB'</b>	<b>A'B'</b>	<b>A'B</b>
<b>C'</b>	1	1	1	X
<b>C</b>	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.

	<b>AB</b>	<b>AB'</b>	<b>A'B'</b>	<b>A'B</b>
<b>CD</b>	X	0	0	1
<b>CD'</b>	X	1	1	1
<b>C'D'</b>	0	0	0	0
<b>C'D</b>	1	0	0	1

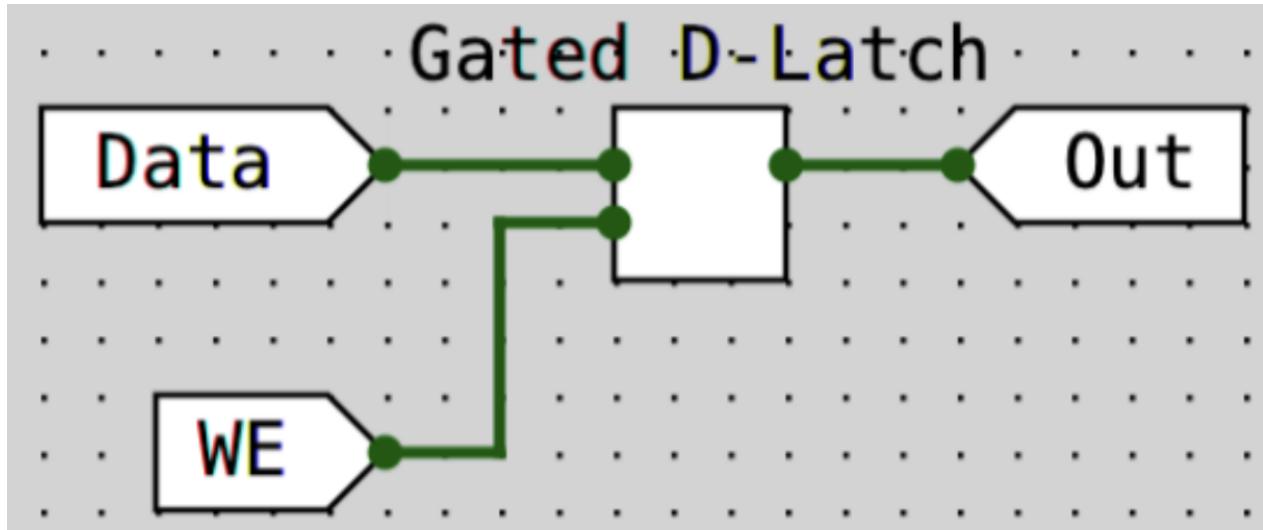
**FORMATTING NOTES:**

- 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)



(b)



(c)



(d)



#### 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)



(b)



(c)



(d)



## 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**?

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?

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**?

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?

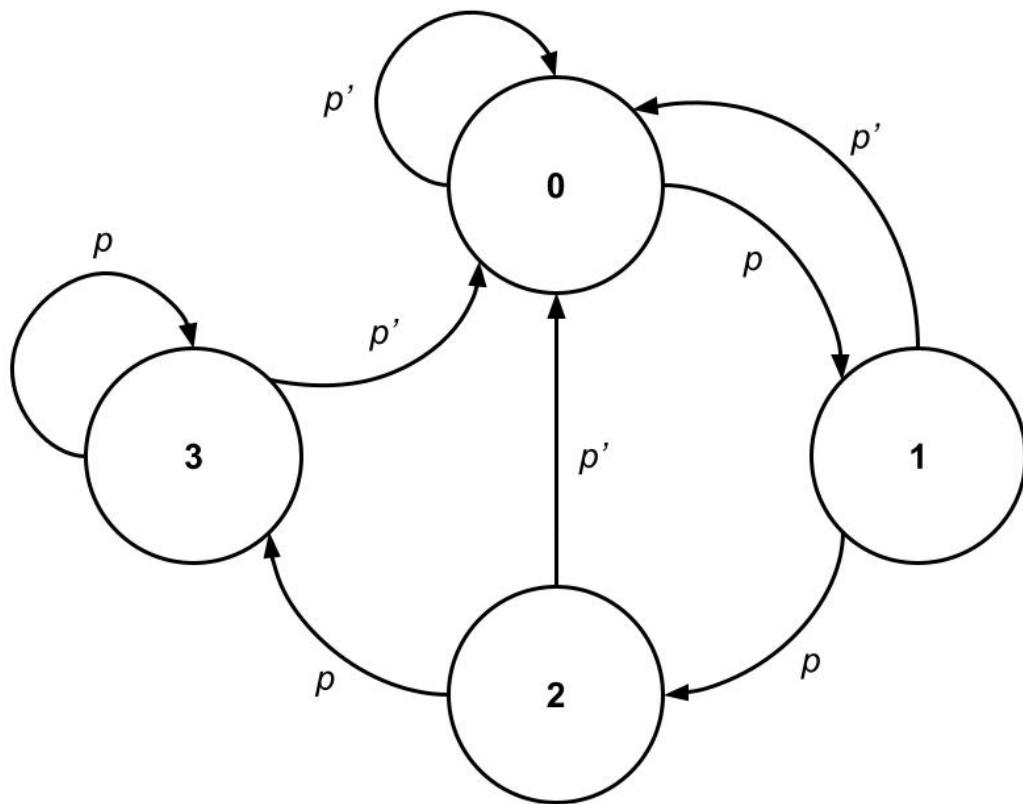
**Q6 Multi-Step State Machine Minimization**

**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...**

- $S_0$  and  $S_1$  entries represent the current state's bit 0 and bit 1, respectively.
- $N_0$  and  $N_1$  entries represent the next state's bit 0 and bit 1, respectively.

*ex. if  $S = 10$ , then  $S_1 = 1$  and  $S_0 = 0$*

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  with the  representing (z0) and  representing (z1) boxes from the truth table, respectively.

row (a) =

row (b) =

row (c) =

row (d) =

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**

	$S_1'S_0'$	$S_1'S_0$	$S_1S_0$	$S_1S_0'$
$p'$	(t0)	(t1)	(t2)	(t3)
$p$	(u0)	(u1)	(u2)	(u3)

**N0 K-Map**

	$S_1'S_0'$	$S_1'S_0$	$S_1S_0$	$S_1S_0'$
$p'$	(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  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

