Important

In order to receive credit for this exam you must comply with the policies stated on this page, and you must be able to sign the integrity commitment at the bottom of this page.

You are permitted to use the textbook for this course during the exam.

You are permitted to use your own personal course notes for ECE 2060 during the exam.

You are permitted to use the ECE 2060 Carmen site for this course (the lecture section Carmen site - Class Number 9487) during the exam.

You are permitted to use the equation sheet that is provided with the exam.

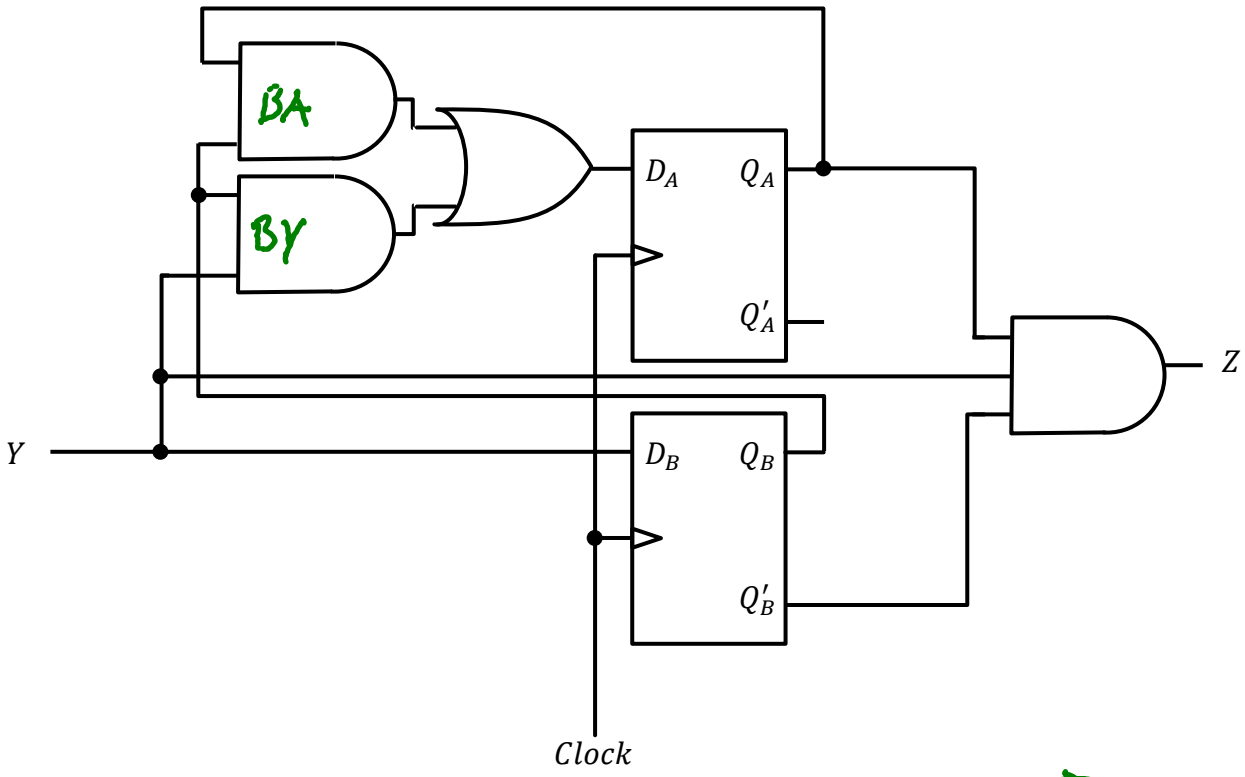
You are permitted to use a calculator.

Integrity Commitment: By signing below I attest that:

1. I will not obtain help from any other person, by any means. The work and answers I submit for the exam will be the product of my effort alone.
2. I will not use any resources other than those stated above (no other books, no other notes, no other online materials or resources, etc.)
3. I will not share my work with anyone else by any means until after the solutions to the exam have been posted on Carmen.

Signature: 	Date: 4/11/23
Print Name: Gage Farmer	

1. [25 points]



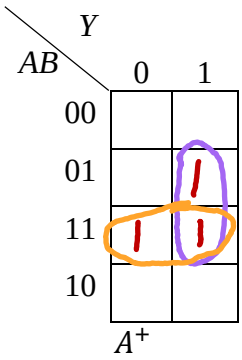
a) (5pts) What type of state machine is this? Moore Machine? Mealy Machine?

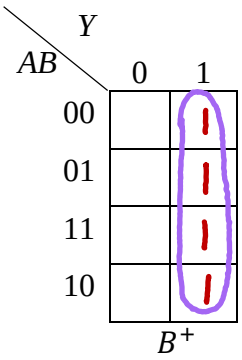
b) (6pts) Determine the expressions for the flip-flop inputs and state machine output.

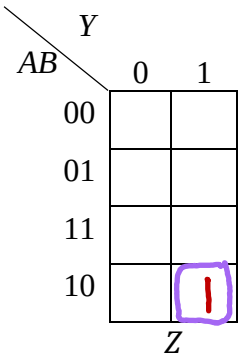
$D_A = A^+ =$ BA + BY $\qquad D_B = B^+ =$ Y

$Z =$ AB'Y

c) (5pts) Complete the Next-State Maps for the flip-flops and the Output Map. Do not change any of the labels on the maps.







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d) (5pts) Complete this Transition Table for the state machine. Do not change any headings or values typed into the table. Note that the left column is not in "truth table order."

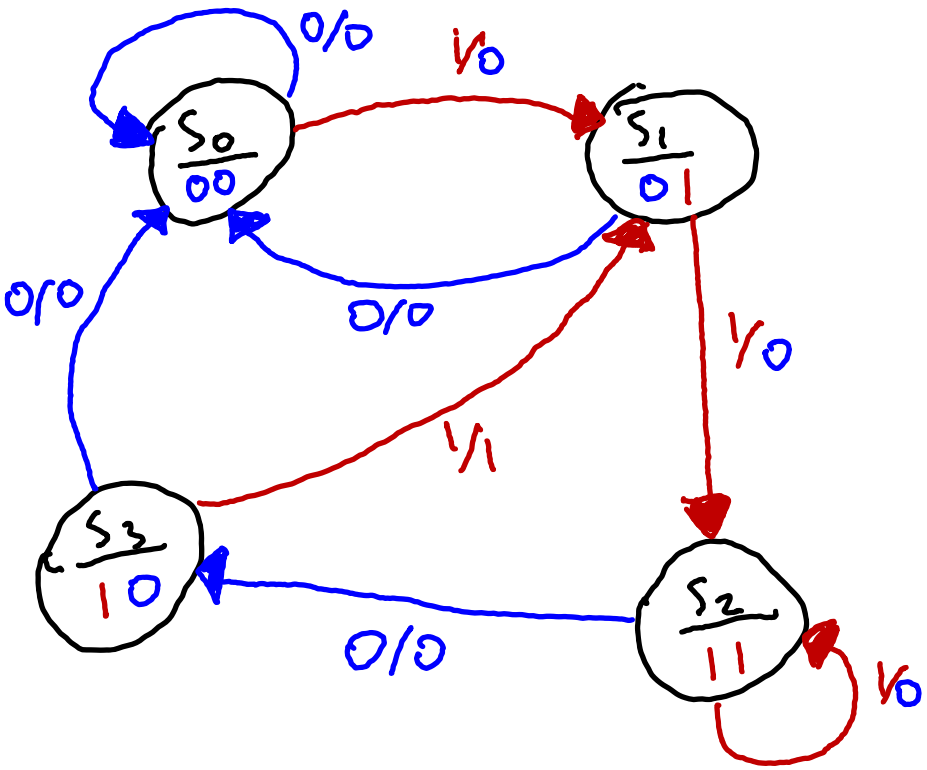
Present State	Next State		Present Output Z	
	$Y = 0$	$Y = 1$		
$A\ B$	$A^+\ B^+$	$A^+\ B^+$	$Y = 0$	$Y = 1$
0 0	0 0	0 1	0	0
0 1	0 0	1 1	0	0
1 1	1 0	1 1	0	0
1 0	0 0	0 1	0	1

e) (5pts) Using the following state definitions, complete the State Table. Do not change any headings or values typed into the table.

$S_0\ (AB = 00)$, $S_1\ (AB = 01)$, $S_2\ (AB = 11)$, $S_3\ (AB = 10)$

Present State	Next State		Present Output Z	
	$Y = 0$	$Y = 1$		
			$Y = 0$	$Y = 1$
S_0	S_0	S_1	0	0
S_1	S_0	S_2	0	0
S_2	S_3	S_2	0	0
S_3	S_0	S_1	0	1

f) (5pts) Draw the properly formatted State Graph.



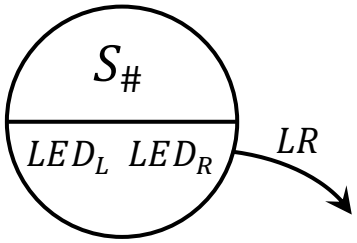
2. [25 points]

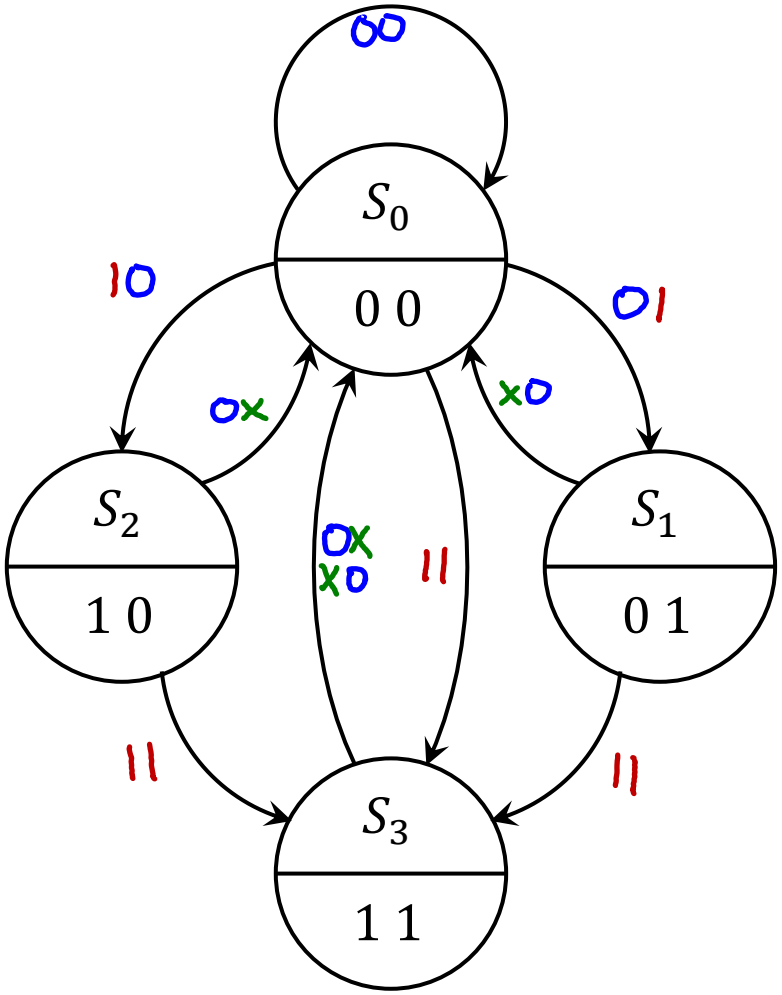
Design a Moore Machine to implement the turn signals and hazard signal for an automobile.

- The state machine will have two inputs L and R, where
  - $LR = 00$ indicates all turn signals are off
  - $LR = 01$ indicates the right turn signal alternates between on and off at each active clock edge,
  - $LR = 10$ indicates the left turn signal alternates between on and off at each active clock edge,
  - $LR = 11$ indicates the hazard lights are operating, whereby both turn signals simultaneously alternate between on and off at each active clock edge.
- The state machine will have two ouptuts, LED_L and LED_R, where a value of 1 indicates the light emitting diode lamps for the front and rear signals for that direction are on and 0 indicates they are off, and the subscripts designate Left and Right, respectively.
- The hazard condition has priority, meaning that both LEDs should turn on at the next active clock edge when $LR = 11$.
- If the turn signal selector is changed from Left to Right or vice versa the LEDs should first go to off before starting to signal the new direction.
- If the inputs are switched from Hazard to Left or Right the LEDs should first go to off before starting to signal the turn direction.

a) (9pts) Label the transitions to complete the properly formatted state graph. Your labels must be placed next to the transitions at locations such that is clear which transistion they correspond to.

Use this as the key for the order for labelling the input values and identifying the output values.





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b) (3pts) Using the following state definitions, complete the State Table. Note that the definitions are different than in Problem 1. Do not change any headings or values typed into the table.

S_0 $(AB = 00)$, S_1 $(AB = 01)$, S_2 $(AB = 10)$, S_3 $(AB = 11)$

Present State	Next State				Present Outputs	
	$LR = 00$	$LR = 01$	$LR = 11$	$LR = 10$	LED_L	LED_R
S_0	S_0	S_1	S_3	S_2	0	0
S_1	S_0	S_1	S_3	S_0	0	1
S_2	S_0	S_0	S_3	S_2	1	0
S_3	S_0	S_0	S_3	S_0	1	1

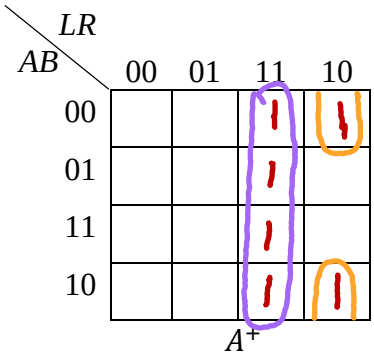
c) (3pts) Complete the Transition Table. Do not change any headings or values typed into the table. Note the change in row order.

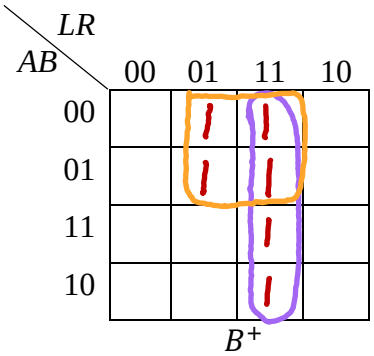
Present State $A\ B$	Next State				Present Outputs	
	$LR = 00$	$LR = 01$	$LR = 11$	$LR = 10$		
	A^+B^+	A^+B^+	A^+B^+	A^+B^+	LED_L	LED_R
0 0	0 0	0 1	1 1	1 0	0	0
0 1	0 0	0 1	1 1	0 0	0	1
1 1	0 0	0 0	1 1	0 0	1	1
1 0	0 0	0 0	1 1	1 0	1	0

d) (1pts) Determine the expressions for the State-Machine outputs in terms of A and B.

$LED_L =$ A $\qquad$ $LED_R =$ B

e) (3pts) Complete the Next State Maps for the flip-flop inputs.





f) (3pts) Determine the fully reduced SOP expressions for the flip-flop inputs.

$D_A = A^+ =$ $LR + B'LR'$ $\qquad$ $D_B = B^+ =$ $LR + A'R$

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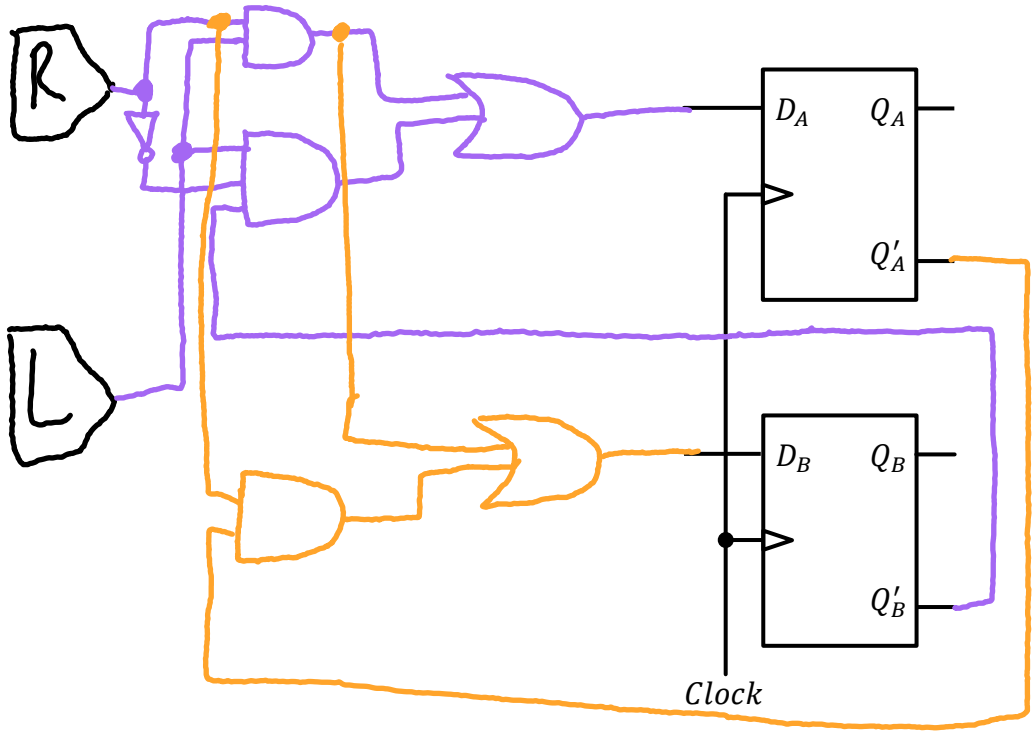
g) (3pts) Draw the circuit diagram. Logic must be implemented with no more than two levels and use only AND and OR gates (and one or two inverters if you need to generate L' or R' from L or R.



Equation Sheet

$$X + 0 = X$$
$$X + 1 = 1$$
$$X \cdot 1 = X$$
$$X \cdot 0 = 0$$

$$X + X = X$$
$$X \cdot X = X$$

$$(X')' = X$$

$$X + X' = 1$$
$$X \cdot X' = 0$$

$$XY = YX$$
$$X + Y = Y + X$$

$$(XY)Z = X(YZ) = XYZ$$

$$(X + Y) + Z = X + (Y + Z) = X + Y + Z$$

$$X(Y + Z) = XY + XZ$$
$$X + YZ = (X + Y)(X + Z)$$

$$\overline{X + Y} = \bar{X}\bar{Y}$$
$$\overline{XY} = \bar{X} + \bar{Y}$$

Half Adder

$$S = X'Y + XY' = X \oplus Y$$
$$C = XY$$

Full Adder

$$S = X \oplus Y \oplus C_{in}$$
$$C_{out} = XY + XC_{in} + YC_{in}$$

$$Q^+ = S + R'Q \ (SR = 0)$$
$$Q^+ = D$$
$$Q^+ = JQ' + K'Q$$
$$Q^+ = TQ' + T'Q$$

Q	Q^+	S	R
0	0	0	X
0	1	1	0
1	0	0	1
1	1	X	0

Q	Q^+	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0