EECE 2160 – Embedded Design: Enabling Robotics

Homework #3

Assigned: Sat., Oct. 12, 2024. Due Sun., Oct. 20, at 11:59pm on Canvas

5 Problems 100 points total

Show your work!

Problem 1. (30 points, 10 points each)

Design a circuit that will tell whether a given month has 31 days in it. The month is specified by a 4-bit input $A_{3:0}$. For example, if the inputs are 0001, the month is January, if the inputs are 1100 the month is December. The circuit output Y should be HIGH only when the month specified by the inputs has 31 days in it.

a. Draw the truth table
b. Draw the simplified equation
c. Draw the circuit diagram using the simplified equation

Hints:

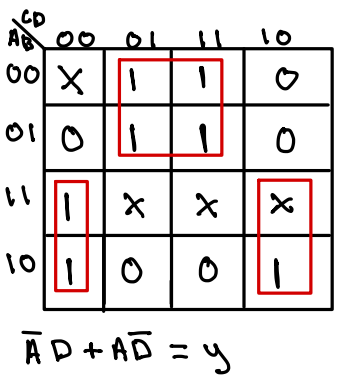
Use a Karnaugh Map for simplification

Take advantage of "don't cares," see lecture 4 slide 32 – 34.

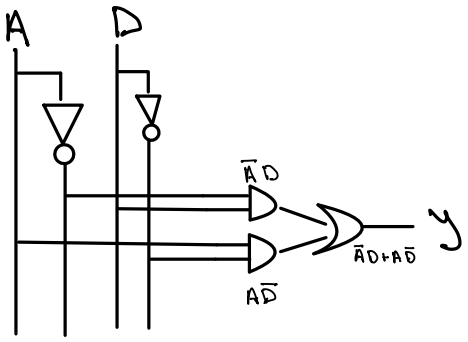
A.

month	a	b	c	d	Y
1	0	0	0	1	1
2	0	0	1	0	0
3	0	0	1	1	1
4	0	1	0	0	0
5	0	1	0	1	1
6	0	1	1	0	0
7	0	1	1	1	1
8	1	0	0	0	1
9	1	0	0	1	0
10	1	0	1	0	1
11	1	0	1	1	0
12	1	1	0	0	1

B.



C.



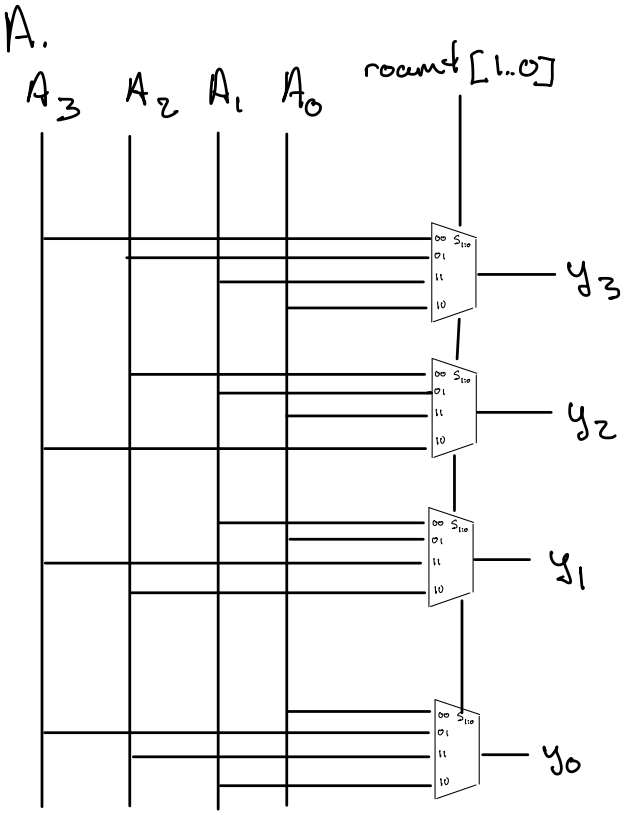
Problem 2. (20 points, 10 points each)

Design 4-bit left and right rotators. There should be a 2-bit input named ***roamt*** that determines how many bits to rotate.

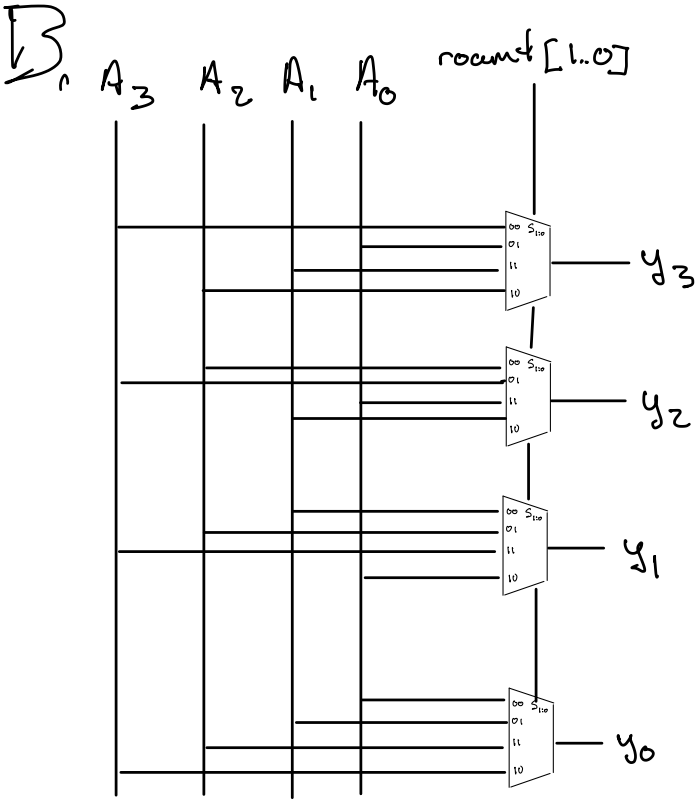
a. 4-bit left rotator: sketch a schematic of your design
b. 4-bit right rotator: sketch a schematic of your design

Hint: look at design of left and right shifters

A.

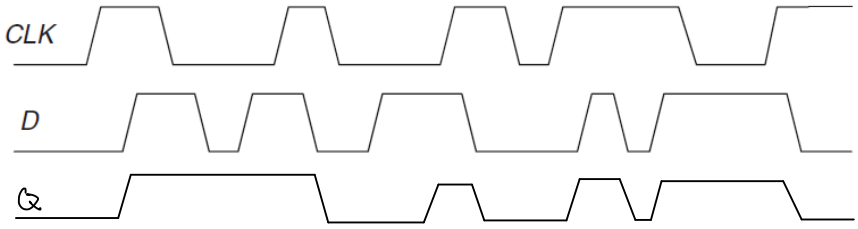


B.

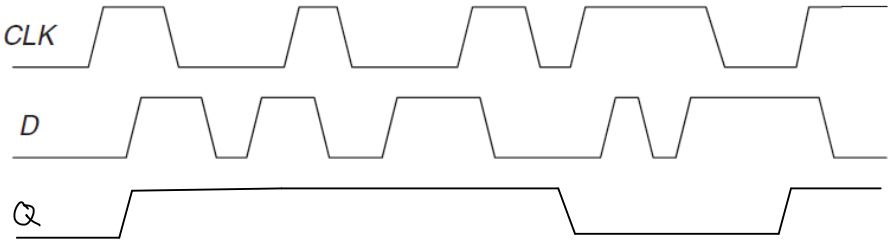


Problem 3. (10 points total, 5 points each)

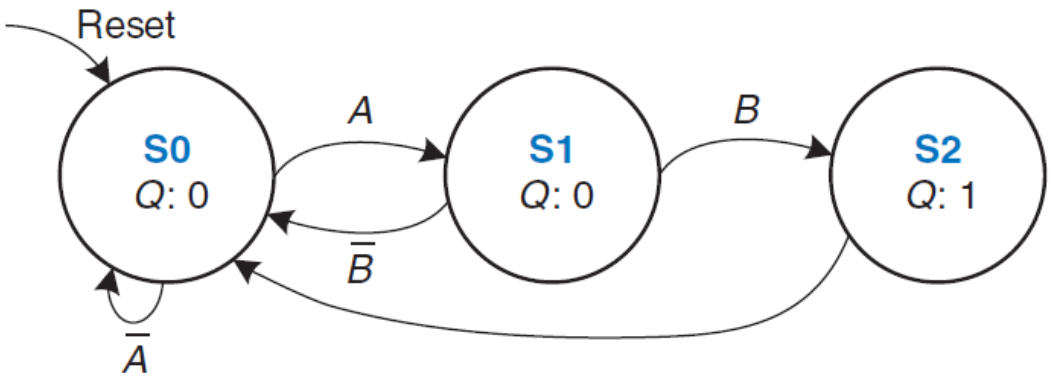
a. For the following waveforms, sketch the output Q of a D-Latch:



b. For the following waveforms, sketch the output Q of a D-Flip-Flop



Problem 4. (20 points) Consider this Moore-type Finite State Machine represented by the state transition diagram below.



Use binary encodings

a. (8 points) Write the following:
   i. State encoding table
   ii. State transition table (using state and input encodings)

b. (2 points) Write the output table (using state and output encodings)

c. (2 points) Write Boolean equations for (simplification optional):
   i. The next state logic
   ii. The output logic

d. (8 points) Sketch a schematic (circuit diagram) of the Finite State Machine.

A.

i.

S_1	S_2	A	B	S_1'	S_2'
0	0	0	X	0	0
0	0	1	X	0	1
0	1	X	0	0	0
0	1	X	1	1	0
1	0	X	X	0	0

ii.

State	encoding
S0	0 0
S1	0 1
S2	1 0

B.

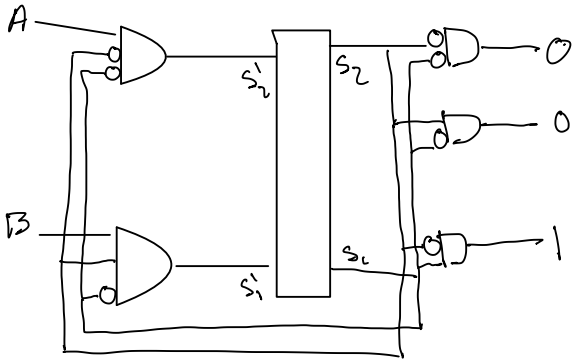
S_1	S_2	Q
0	0	0
0	1	0
1	0	1

C.

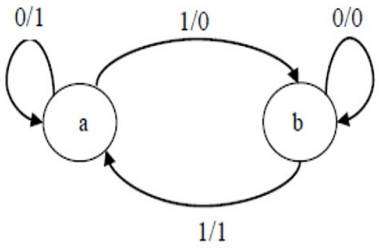
$S_1' = \overline{S}_1 S_2 B$

$S_2' = \overline{S}_1 \overline{S}_2 A$

D.



Problem 5. (20 points total, 10 points each) Design a sequential logic circuit to implement the following state diagram of a Mealy-type Finite State Machine.



a. Fill-in the state table (table has more rows than needed)

Current State	Input	Next State	Output
Q	**X**	**Q***	**Y**
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

b. Draw the schematic diagram of the circuit.

$Q^* = Q \oplus X$

$y = Q \cdot X$