

CL=CSCI 160

CLASS 19

Design an indicator circuit for a room with two swinging doors, call them D_1, D_2 . There are two switches S_{i1}, S_{i2} , associated to each D_i (that is S_{11}, S_{12} , associated to D_1 , and that is S_{21}, S_{22} , associated to D_2) that work in the following way:

S_{i1} is closed, expressed by $S_{i1} = 1$, exactly then when the door D_i is open in, for $i=1,2$;
 S_{i2} is closed, expressed by $S_{i2} = 1$, exactly then when the door D_i is open out, for $i=1,2$.

We need to construct a circuit that lights a lamp, L , exactly then when *there is a clear path through the room, that is when one of the doors is open in and the other door is open out*.

- Give:
- the truth table with inputs $S_{11}, S_{12}, S_{21}, S_{22}$ and the output function L ,
 - the corresponding 4-variable (use the 4 variables, S_{ij} , as above at 1.) K-map for the function L , and
 - all the minimized forms for the function L .

Note: For each door, only two positions are recorded: in and out. Some input combinations never occurs, and you should make use of this fact in minimizing L .

$S_{11} = 0; S_{12} = 1$
 $S_{11} = 1; S_{12} = 0$
 $S_{21} = 1; S_{22} = 0$
 $S_{21} = 0; S_{22} = 1$

Flow ----> $L = 1$ Flow ----> $L = 1$

Note: Each of the two 1s may be covered independently by 4 size-4 prime implicants

3.

$$L_{1-16} = \left\{ \begin{matrix} A \text{ or} \\ B \text{ or} \\ C \text{ or} \\ D \end{matrix} \right\} + \left\{ \begin{matrix} E \text{ or} \\ F \text{ or} \\ G \text{ or} \\ H \end{matrix} \right\} =$$

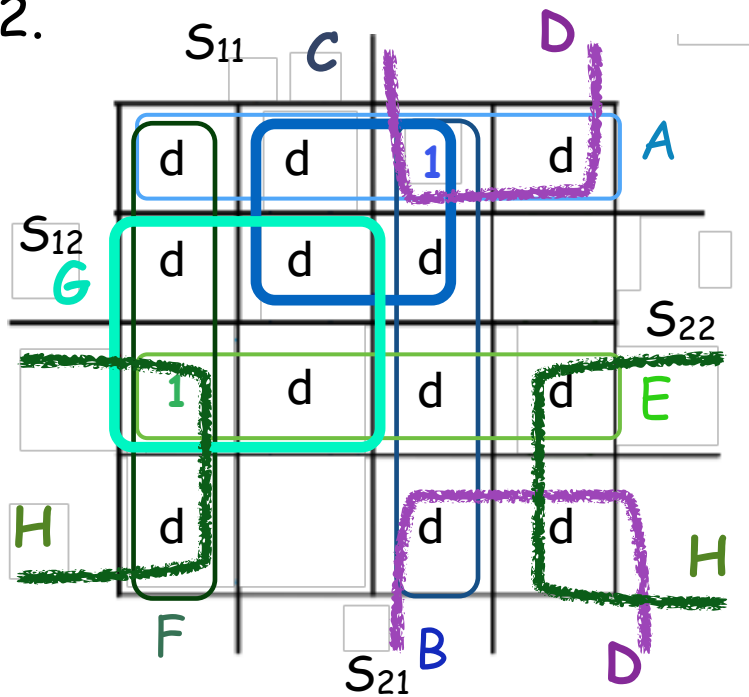
$$= \left\{ \begin{matrix} S_{12} S'_{22} \\ S'_{11} S_{21} \\ S_{12} S_{21} \\ S'_{11} S'_{22} \end{matrix} \right\} + \left\{ \begin{matrix} S'_{12} S_{22} \\ S_{11} S'_{21} \\ S_{11} S_{22} \\ S'_{12} S'_{21} \end{matrix} \right\}$$

Quiz 2.3 Solution

We must have: $S_{11} = S'_{12}; S_{21} = S'_{22}$
The other input will never occur ----> d

1.

S_{11}	S_{12}	S_{21}	S_{22}	L
0	0	0	0	d
0	0	0	1	d
0	0	1	0	d
0	0	1	1	d
0	1	0	0	d
0	1	0	1	0
0	1	1	0	1
0	1	1	1	d
1	0	0	0	d
1	0	0	1	1
1	0	1	0	0
1	0	1	1	d
1	1	0	0	d
1	1	0	1	d
1	1	1	0	d
1	1	1	1	d



CONTROLLERS (CONTROLLED INPUT)

Problem

Let A be an input ('external'-we are not interested in its value), and Y the output of this control circuit.

We need to sometimes produce $Y = A$, and at other times produce $Y = A'$. We will use a control line called C . What is special about controllers is that we use the control line(s) as input, and not the 'external' input, which we want to control, in this case A , when setting the truth table..

Solution

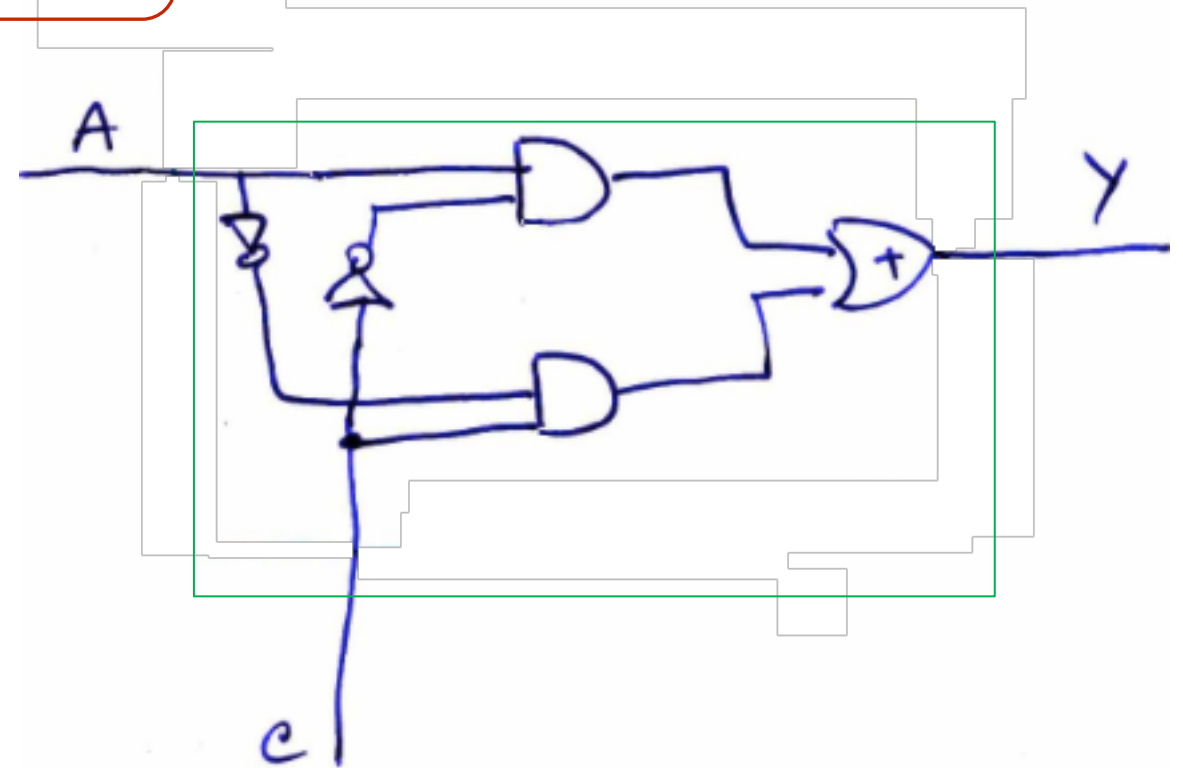
Truth table: Input = Control Line(s)

C	Y
0	A
1	A'

Expression of function:

$$Y = C'A + CA'$$

Logic diagram:



CONTROLLED INPUT (continued)

Problem

* Input (external): A

* Output Y should equal:

- * at times A
- * at other times A'
- * yet at other times 0
- * yet at other times 1

Solution

How many different outputs do we have? 4 How many controllers do we need to create the 4 different outputs? 2

Truth table:

α	β	Y
0	0	A
0	1	A'
1	0	0
1	1	1

$$Y = \alpha'\beta'A + \alpha'\beta A' + \cancel{\alpha\beta'0} + \alpha\beta$$

$$Y = \alpha'\beta'A + \alpha'\beta A' + \alpha\beta$$

CONTROLLED INPUT (continued)

MULTIPLEXER

* 4 inputs (external): I_0, I_1, I_2, I_3 ,

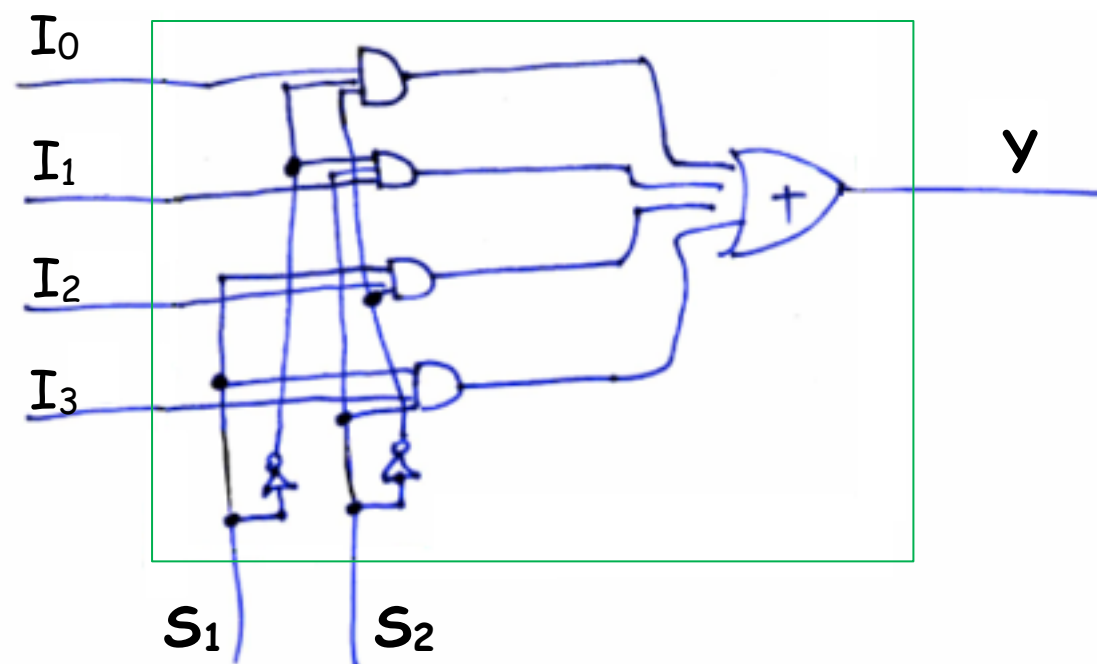
* 1 output: $Y = \begin{cases} * \text{ at times } I_0 \\ * \text{ at other times } I_1 \\ * \text{ yet at other times } I_2 \\ * \text{ yet at other times } I_3 \end{cases}$

How many controllers do we need to create the 4 different outputs? 2

Let's call them 'selectors' in this case: S_1, S_2

S_1	S_2	Y
0	0	I_0
0	1	I_1
1	0	I_2
1	1	I_3

$$Y = S'_1 S'_2 I_0 + S'_1 S_2 I_1 + S_1 S'_2 I_2 + S_1 S_2 I_3$$



CONTROLLED INPUT (continued)

DEMULTIPLEXER

* 1 input (external): **I**

* 4 outputs: Y_0 , Y_1 , Y_2 , Y_3 , as follows:

S_1	S_2	Y_0	Y_1	Y_2	Y_3
0	0	I	0	0	0
0	1	0	I	0	0
1	0	0	0	I	0
1	1	0	0	0	I

How many controllers do we need to
create the 4 different outputs for the 4 functions)? 2

$$Y_0 = S'_1 S'_2 I$$

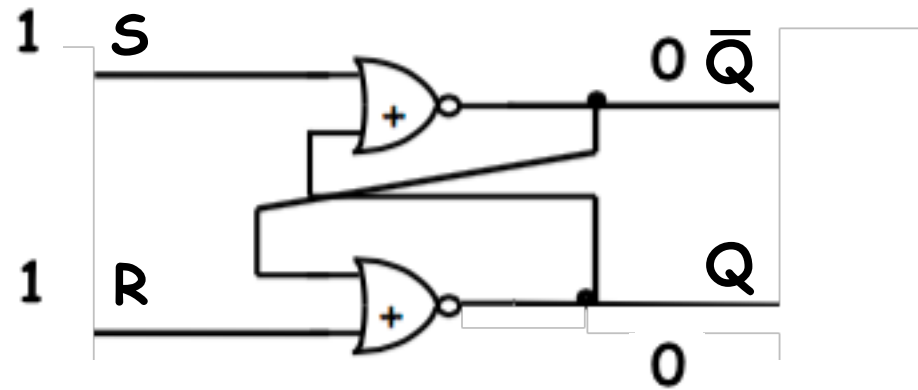
$$Y_1 = S'_1 S_2 I$$

$$Y_2 = S_1 S'_2 I$$

$$Y_3 = S_1 S_2 I$$

S-R FLIP-FLOP (set-reset)

Truth table:



S	R	Q	\bar{Q}
0	0	PS = 0 \rightarrow stays 0 PS = 1 \rightarrow stays 1	PS
0	1	0	1
1	0	1	0
1	1	0	0

PS stands for
Previous State

Not allowed !

Exclude the 1-1 input for S-R Flip-Flop, as we cannot have $Q = \bar{Q}$, and we want complementary outputs!

The truth table becomes:

S	R	Q
0	0	PS
0	1	0
1	0	1

HW 19 - assigned

Evaluate the following flip-flop, by giving its truth table.

