Controlled Input

CLASS 17

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:

1. the truth table with inputs S_{11}, S_{12}, S_{21}, S_{22} and the output function L,
2. the corresponding 4-variable (use the 4 variables, S_{ij}, as above at 1.) K-map for the function L, and
3. 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.

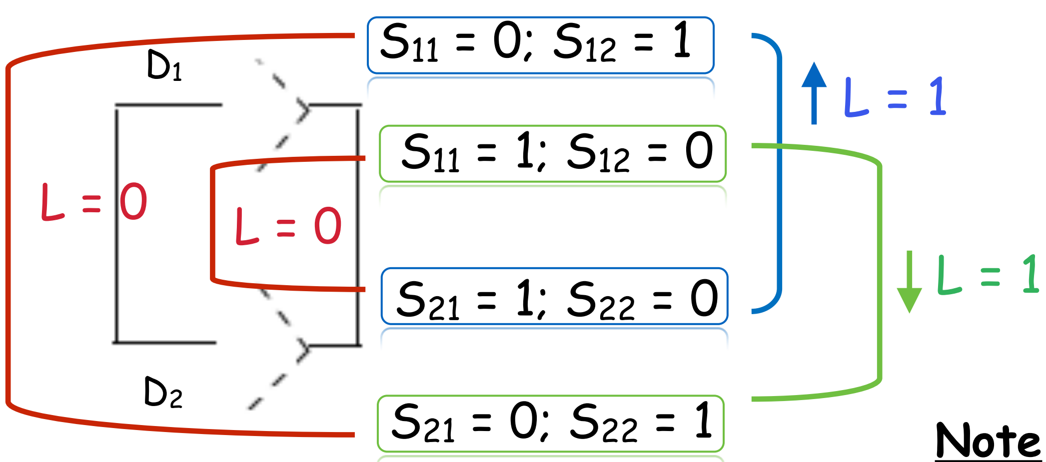
Quiz 2.3 Solution

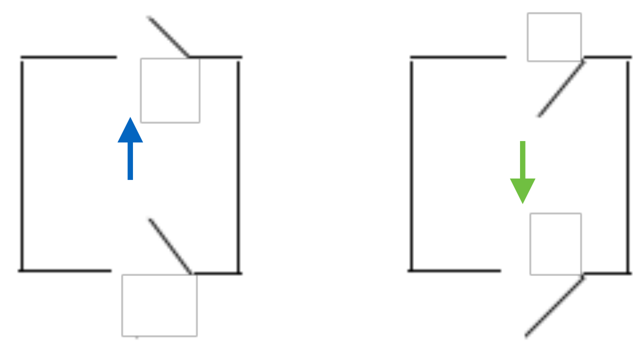
We must have: $S_{11} = S'_{12}$; $S_{21} = S'_{22}$

The other input will never occur ---> d

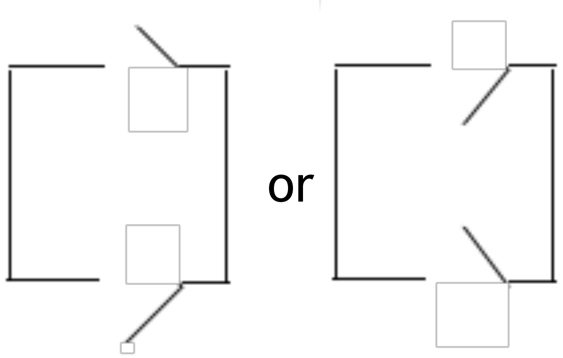
1.

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





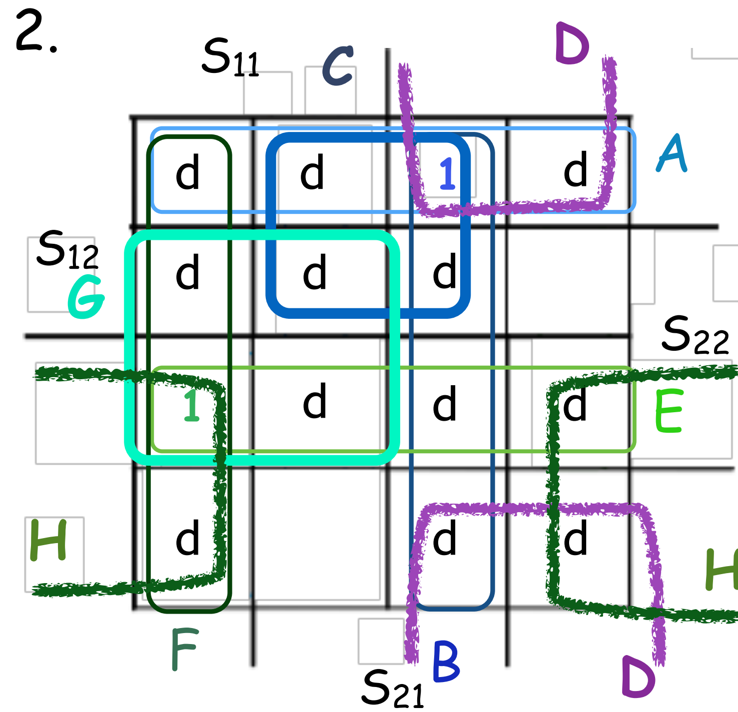
Flow ---> L = 1 Flow ---> L = 1



No Flow ---> L = 0

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

2.



3.

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

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

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

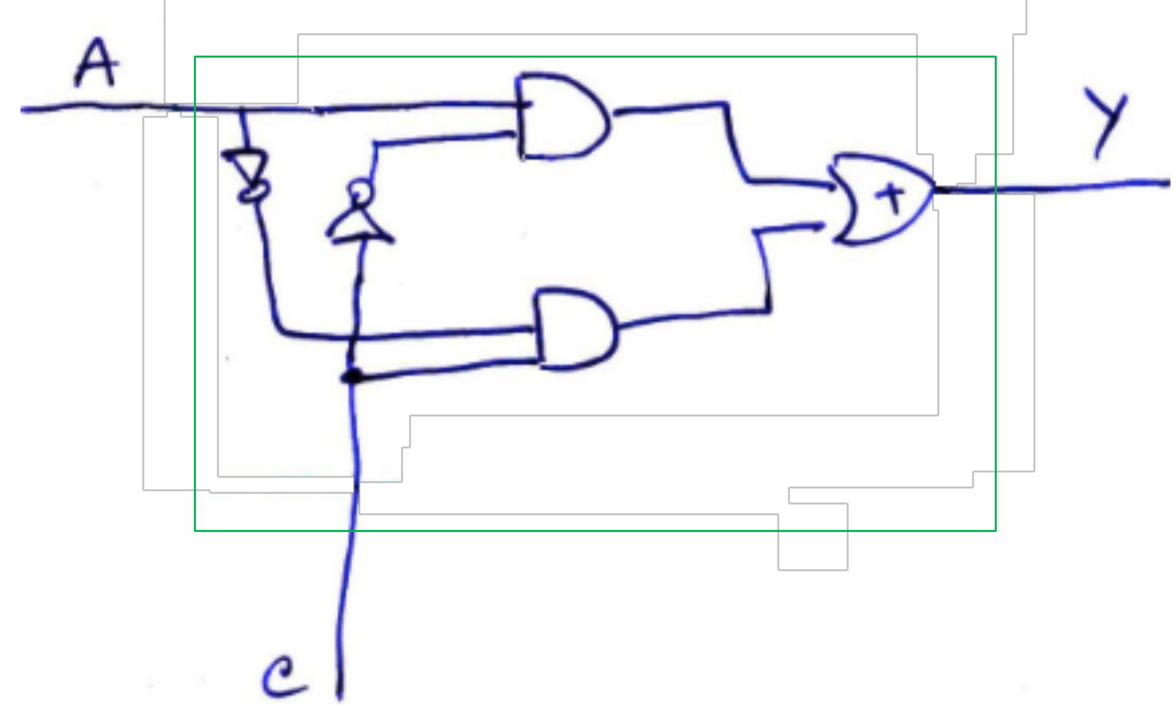
Truth table: Input = Control Line(s)

C	Y
0	A
1	A'

Expression of function:

$\boxed{Y = C'A + CA'}$

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

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

$$\boxed{Y = \alpha'\beta'A + \alpha'\beta A' + \alpha\beta}$$

CONTROLLED INPUT (continued)

MULTIPLEXER

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

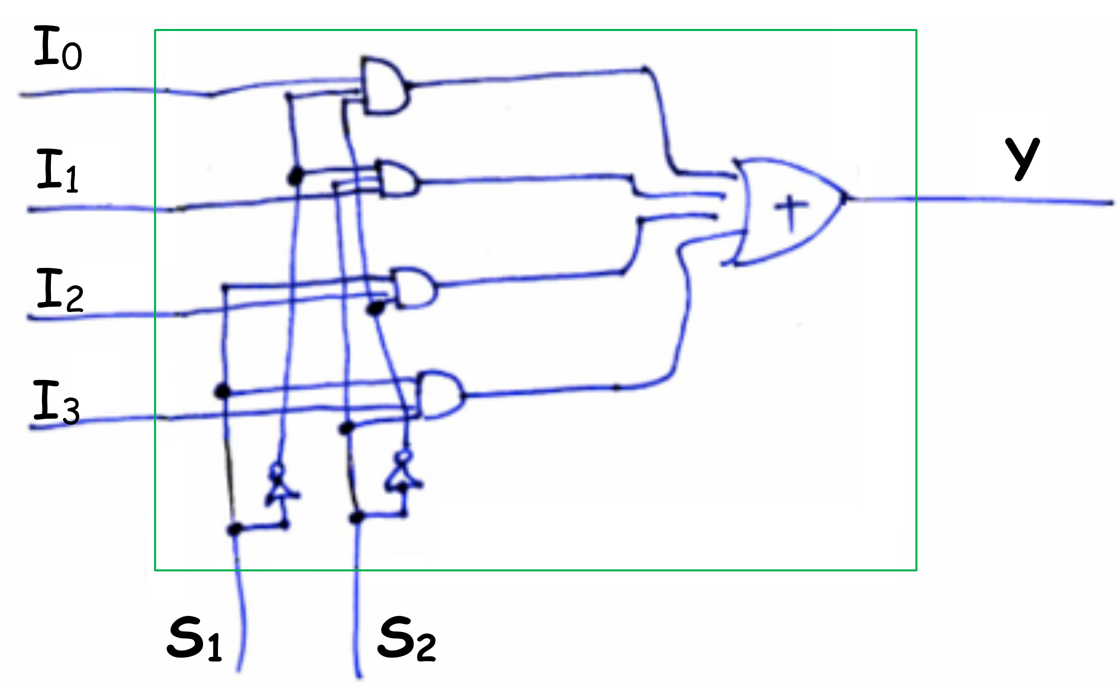
* 1 output: Y =
  * at times I_0
  * at other times I_1
  * yet at other times I_2
  * yet at other times I_3

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

$$Y = S'_1S'_2I_0 + S'_1S_2I_1 + S_1S'_2I_2 + S_1S_2I_3$$



CONTROLLED INPUT (continued)

DEMULTIPLEXER

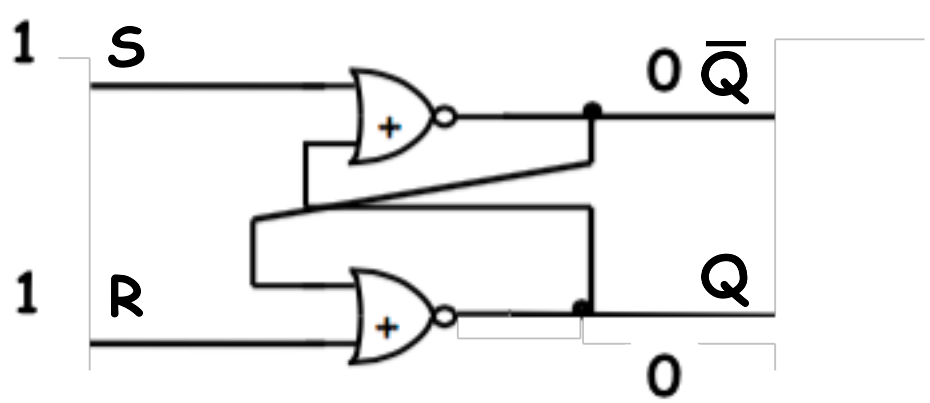
* 1 input (external): **I**
* 4 outputs: Y_0, Y_1, Y_2, Y_3, as follows:

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 -->stays 0 PS = 1 -->stays 1 } PS	PS
0	1	0	1
1	0	1	0
1	1	0	0

Not allowed !

PS stands for Previous State

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.