

Implementation of Boolean Logic in Arduino using Vaman

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1 Problem

(Gate EC-2021)

Q.31. The propagation delays of the XOR gate, AND gate and multiplexer (MUX) in the circuit shown in the figure are 4 ns, 2 ns and 1 ns, respectively.

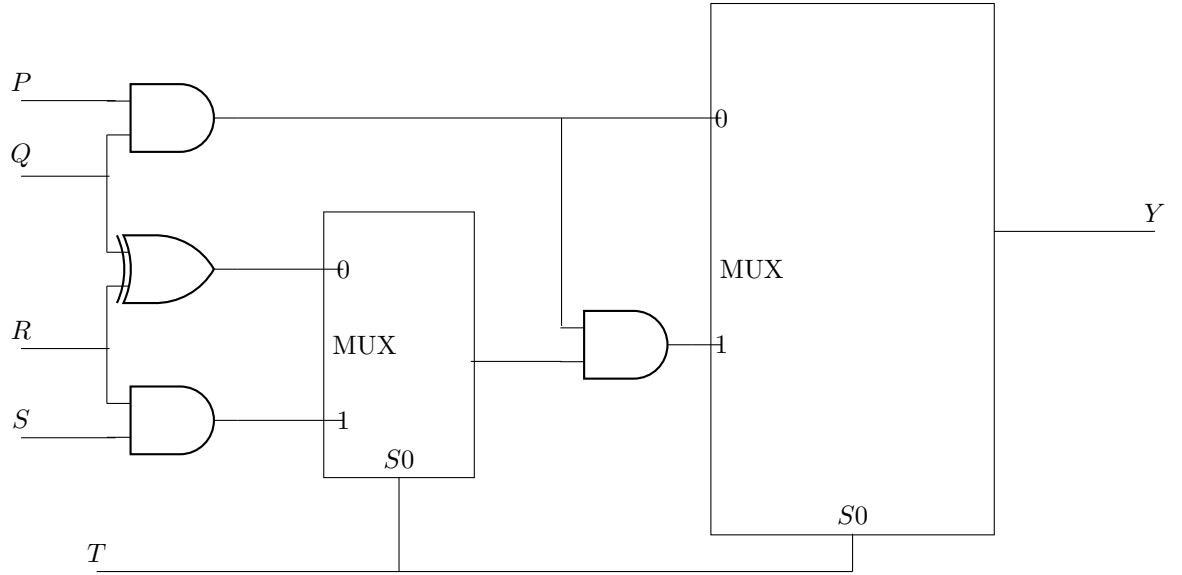


Figure 1: State diagram

If all the inputs P, Q, R, S and T are applied simultaneously and held constant, the maximum propagation delay of the circuit is

1. 3 ns
2. 5 ns
3. 6 ns
4. 7 ns

2 Introduction

In the given circuit, the output of first multiplexer can be considered as the input to the second multiplexer so that the second multiplexer can be analyzed using 7447 IC for the implementation of output (expression) of the second multiplexer. Since the 7447 IC is just a seven segment display decoder, the output expression of the multiplexer can be given to the LSB representing pin (7) of the IC so

that the output on the display will represent the required answer (0 or 1) with the inputs of the given circuit (P,Q,R,S,T) being given at random.

3 Components

Table 1: Table1

COMPONENTS		
Component	Value	Quantity
Resistor	220 Ohm	1
Arduino	UNO	1
Seven Segment Display		1
Decoder	7447	1
Jumper Wires	M-M	20
Breadboard		1

Table 2: Components

4 Hardware

1. Make Connections between the seven segment display in and the 7447 IC as shown in Table2.

Table 3: Table2

7447 - Display							
7447	\bar{a}	b	\bar{c}	d	\bar{e}	f	\bar{g}
Display	a	b	c	d	e	f	g

Table 4: Components

2. Connect Vcc of the IC and COM of the display to 5V and the GND pins of the IC and display to the Ground of arduino.

5 Software

1. Now make the connections as per Table3.
2. In the truth table in Table4, P,Q,R,S,T are the inputs and Y is the output.
3. The k map for this truth table will be a five variable k map. So, two k maps can be drawn with one map having one input variable as zero and the other k map having that input variable as one as shown below

Table 5: Table3

7447 - Arduino				
7447	D	C	B	A
Arduino	5	4	3	2

Table 6: Components

Table 7: Table4

Truth Table					
P	Q	R	S	T	Y
x	x	0	x	x	0
x	x	x	0	x	0
0	0	x	x	1	0
x	x	1	1	0	1
1	1	1	1	x	1

Table 8: Components

		T						T					
		00	01	11	10			00	01	11	10		
S	00		0	0	0	0			0	0	0	0	
	01		0	0	0	1			0	0	0	1	
	11		0	0	0	1			0	0	1	1	
	10		0	0	0	0			0	0	0	0	
QP													
		$R=0$						$R=1$					

4. Since, 7447 is a Seven Segment Display decoder, A represents the LSB and D represents the MSB. So giving the input to A displays either 0 or 1 on the Display.
5. Since, the output of the mux is either 0 or 1, this output of mux i.e., Y can be given as input to A of the 7447 IC so that the output of the mux can be observed directly on the display.
6. The boolean expression for the output (Y) of the second mux with the

inputs (P,Q,R,S,T) will be simplified as 1

$$Y = RS(T' + PQ) \quad (1)$$

7. The code below realizes the Boolean logic for A with y being the input to A.

<https://github.com/GUNA5801/FWC/blob/main/vaman/arm/src/main.c>

8. Execute the above code and compare the results of output theoretically and practically.