

# IMPLEMENTATION OF BOOLEAN LOGIC BY USING ARDUINO WITH AVR-GCC

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## 1 Problem

(Gate EC-2021)

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

If all the inputs P,Q,R,S and T are applied simul-

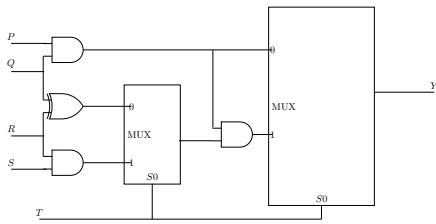


Figure 1: Circuit

taneously and held constant,the maximum propaga-  
tion delay of the circuit is

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

## 2 Intoduction

In the given circuit,the output of first multiplexer-  
can be considered as the input to the second mul-  
tiplexr so that the second multiplexer can be ana-  
lyzed using 7447 IC for the implementation of out-  
put(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 deisplay 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

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

Table 1: Components

### 3.1 Arduino

The Arduino Uno has some ground pins,analog in-  
put pins A0-A3 and digital pins D1-D13 that can  
be used for both input as well as output.It also has  
two power pins that can generate 3.3V and 5V.Inthe  
following exercises, we use digital pins,GND and 5V  
.

### 3.2 Seven Segment Display

The seven segment display has eight pins,  
*a,b,c,d,e,f,g* and *dot* that take an active LOW in-  
put,i.e. the LED will glow only if the input is con-  
nected to ground.Each of these pins is connected

to an LED segment. The *dot* pin is reserved for the LED.

## 4 Hardware

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

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

Table 2: seven segment

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.
3. Now make the connections as per Table3.

7447	D	C	B	A
Arduino	5	4	3	2

Table 3: Connections

4. In the truth table in Table4, P,Q,R,S,T are inputs and Y is output.

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 4: Truth Table

5. The k map for this truth table will be a five variable 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.

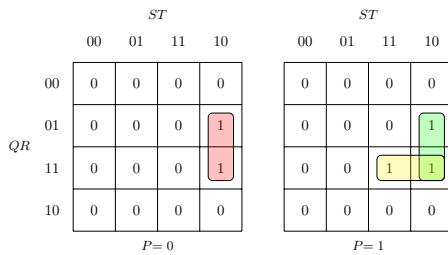


Figure 2: For Y

6. 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.

7. 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.
8. The boolean expression for the output (Y) of the second mux with the inputs (P,Q,R,S,T) will be simplified as

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

## 5 Software

Now execute the following code and upload in arduino to realize the Boolean logic for A with y being the input to A.

```
#include <avr/io.h>
#include <util/delay.h>

int main(void)
{
    int P,Q,R,S,T;
    int Y;

    DDRD &= ~(1<<PD2)&(1<<PD3)&(1<<PD4)&(1<<PD5)
           &(1<<PD6);

    DDRB |= (1<<PB5);

    while(1)
    {
        P=(PIND & (1<<PIND2)) == (1<<PIND2);
        Q=(PIND & (1<<PIND3)) == (1<<PIND3);
        R=(PIND & (1<<PIND4)) == (1<<PIND4);
        S=(PIND & (1<<PIND5)) == (1<<PIND5);
        T=(PIND & (1<<PIND6)) == (1<<PIND6);

        Y=(P&&Q) && ((!T)|| (R&&S));

        PORTB = (Y<<5);

    }

    return 0;
}
```