Digital Systems and Microprocessor (MCTE 2332)

Semester I, 2020/2021

DIGITAL LOGIC DESIGN PROJECT:
2-WAY TRAFFIC LIGHT SYSTEM

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1.0 GOAL OF THE PROJECT

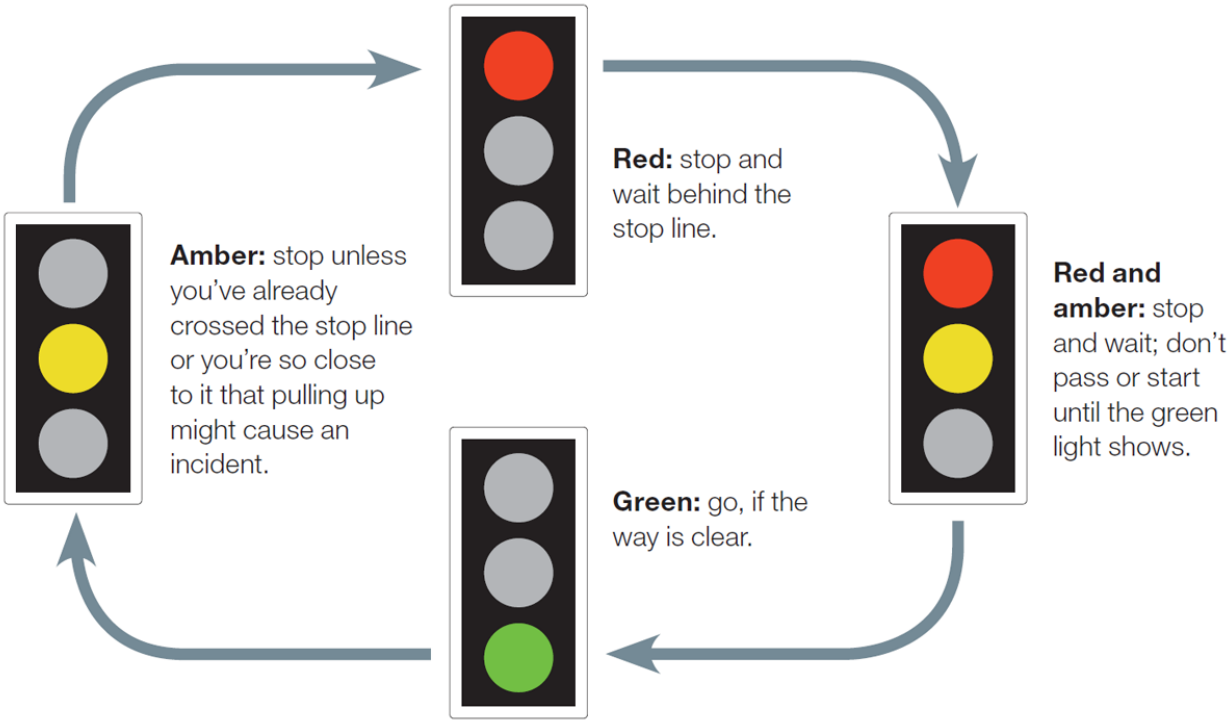
Statistics have shown that the number of cases related to road traffic accidents increases throughout 2012 until now. According to The Star newspaper, they stated that Malaysia has the third highest death rate in Asian. The fourth most common cause of death in Malaysia is from Transport accidents. Therefore, due to the big number of vehicles that have high chances of causing traffic road accidents, in order to minimize it, I have come up to this project which is called The Two Ways Traffic Light System. This project offers to develop a traffic signal controller in which it aims to control the working of traffic lights in motion of cars other than maintaining the safety of both humans and transports. Other than that, it allows the pedestrian to walk to the other side of the road.

In the making of this project, some logic gates that are being practiced is the sequential logic design. The gates that are mostly implemented are AND, OR and NOT gates. In addition, the synchronous D flip flop is also applied to clocked the system. Generally, the system operates in sequence where we can control the movement of transports in two different directions. The sequence is illustrated by using LED light that follows the universal standard colour code which is green, red and yellow and it also represents the traffic light in the road. Green light indicates that the car can move while red means the car has to stop moving and has to allow the other direction to continue their journey. Furthermore, yellow light is to alert the passengers or drivers whether they have to stop or not.

2.0 DESIGN PROCESS

The working of this project is there are 2 different ways for car movement. The 6 LEDs in this project will be used to indicate the flow of traffic at junctions in determining which vehicles may proceed first. The basic colours that are used are RED, GREEN and YELLOW light. Table below portrays the description for each LED colour.

One Light	Cross Light	Description
Green	Red	Traffic on one street moving
Yellow/Amber	Red	Cross-street traffic has to wait for this light to turn red
Red	Red	Both lights are red for a second
Red	Green	Cross traffic can pass now



3.0 DETAILED DESIGN

In designing the logic circuit for this project, the 3-bit synchronous counter using D flip flop will be implemented to portray the 2 traffic lights. For 3-bit synchronous counter, there are 6 states which are binary 000 until 101. The other two states, binary 110 and 111 are ignored in which, it will return to 000 states, RED light for both traffic lights. To determine the number of flip flop count, we will set it by looking at the number of states used. As for this project, the state that is functioning is only 6 states. Below is on how to calculate the flip flop count.

$$N = 6$$

$2^{P-1} < N <= 2^{P}$, where P is the number of flip flops.

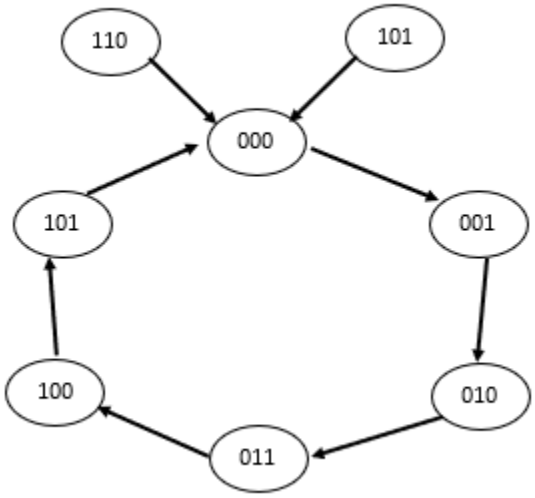
Hence, $P = 3$

Thus, the states are denoted by Qa, Qb and Qc by measuring the number of flip flops.

1) The table below indicates the state for the output sequence of light colour.

State	Light 1	Light 2
000	Red	Red
001	Red	Green
010	Red	Yellow
011	Red	Red
100	Green	Red
101	Yellow	Red
110	Red	Red
111	Red	Red

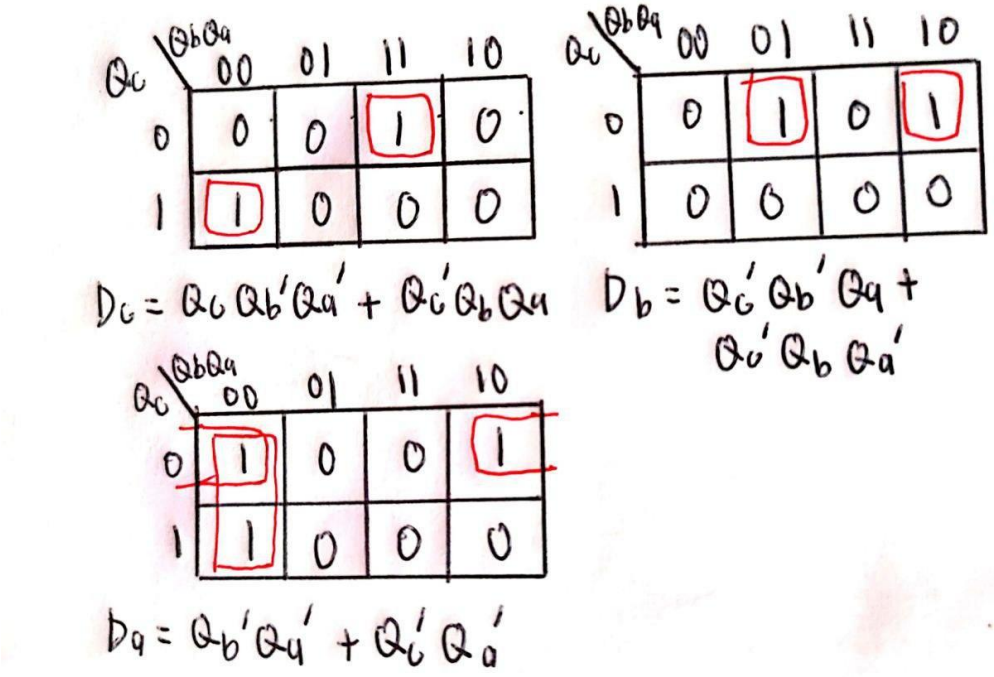
2) State diagram for the system.



3) Input Flip Flop Transition Table.

Present State			**Next State**			**D Transition**		
Qc	Qb	Qa	Qc+*1*	Qb+*1*	Qa+*1*	Dc	Db	Da
0	0	0	0	0	1	0	0	1
0	0	1	0	1	0	0	1	0
0	1	0	0	1	1	0	1	1
0	1	1	1	0	0	1	0	0
1	0	0	1	0	1	1	0	1
1	0	1	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0

4) K-Map to get the logic equation.



5) Truth Table for the output equation.

Input			**Traffic Light 1**			**Traffic Light 2**		
Qc	Qb	Qa	R1	G1	Y1	R2	G2	Y2
0	0	0	1	0	0	1	0	0
0	0	1	1	0	0	0	1	0
0	1	0	1	0	0	0	0	1
0	1	1	1	0	0	1	0	0
1	0	0	0	1	0	1	0	0
1	0	1	0	0	1	1	0	0
1	1	0	1	0	0	1	0	0
1	1	1	1	0	0	1	0	0

6) Output Equation.

G1 = Qc x Qb’ x Qa’

G2 = Qc’ x Qb’ x Qa

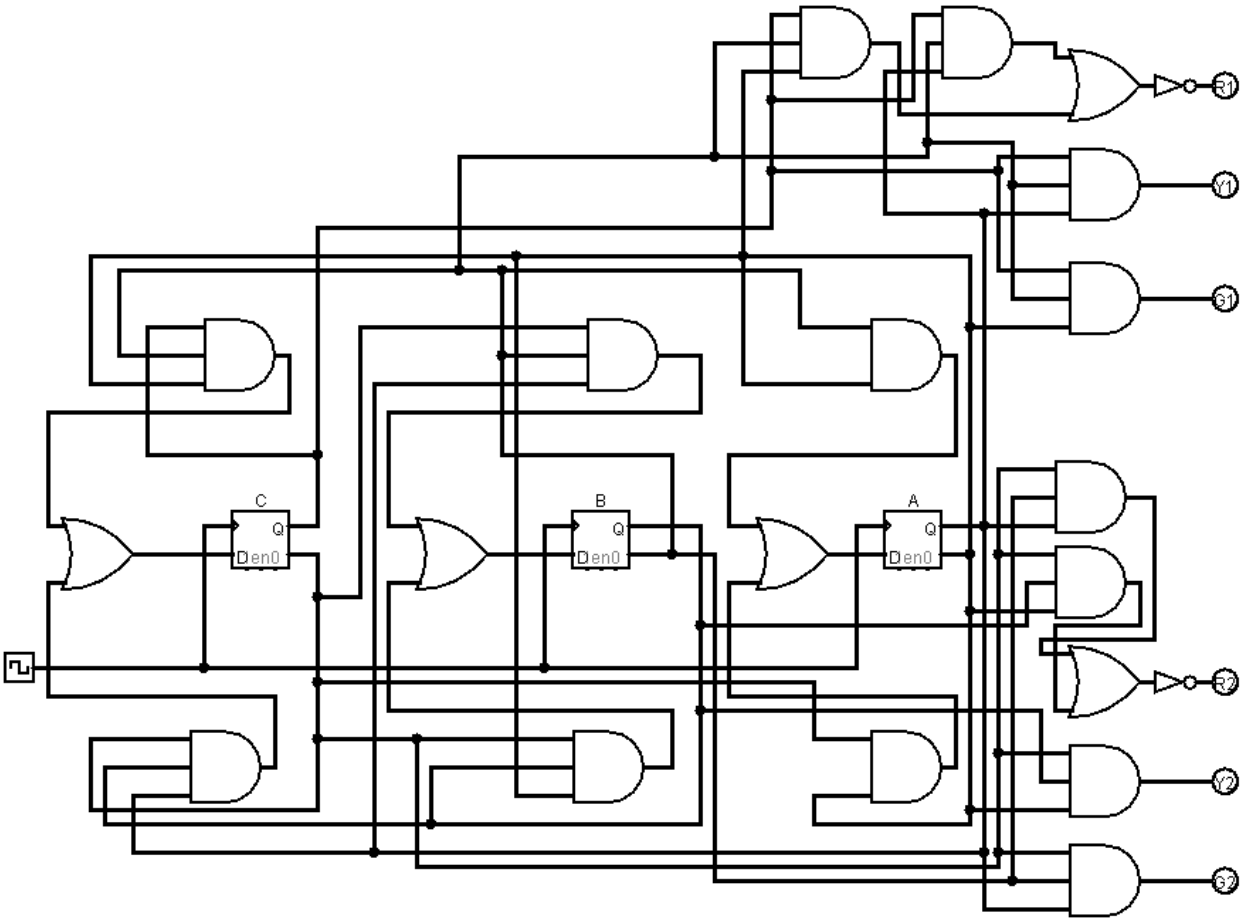
Y1 = Qc x Qb’ x Qa

Y2 = Qc’ x Qb x Qa’

R1 = [(Qc x Qb’ x Qa’) + (Qc x Qb’ x Qa)]’

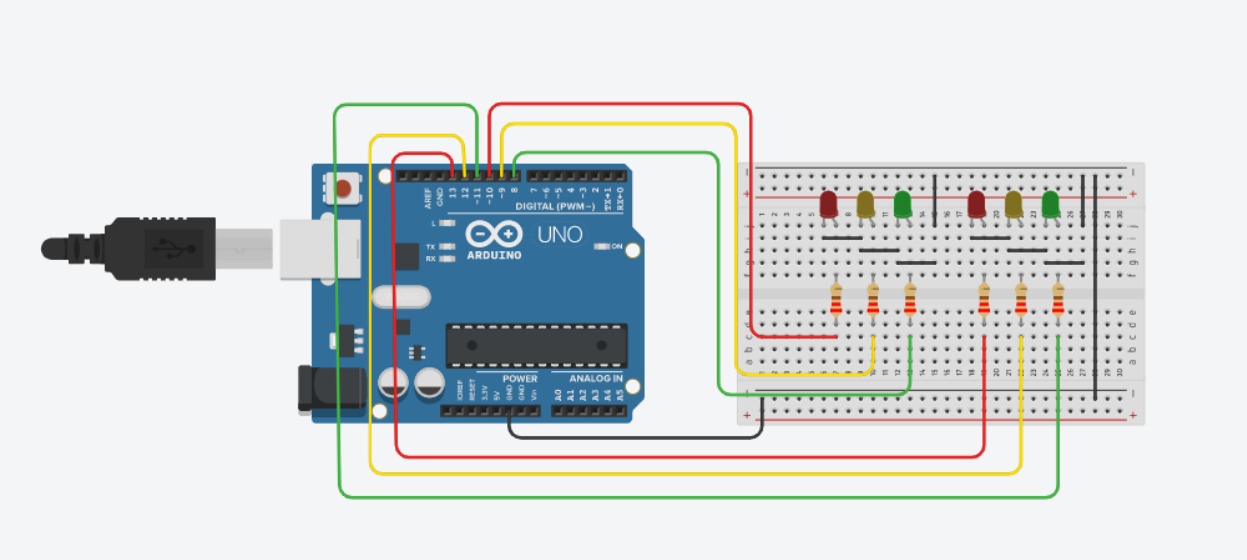
R2 = [(Qc’ x Qb’ x Qa) + (Qc’ x Qb x Qa)]’

7) Logic circuit.

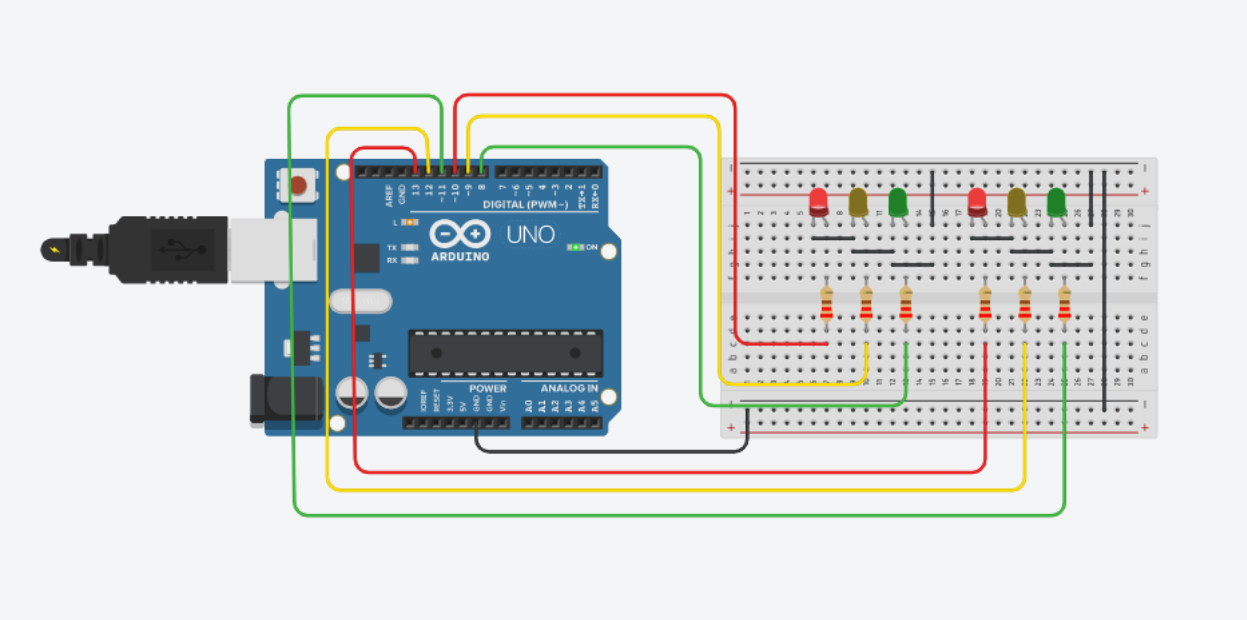


4.0 DESIGN VERIFICATION

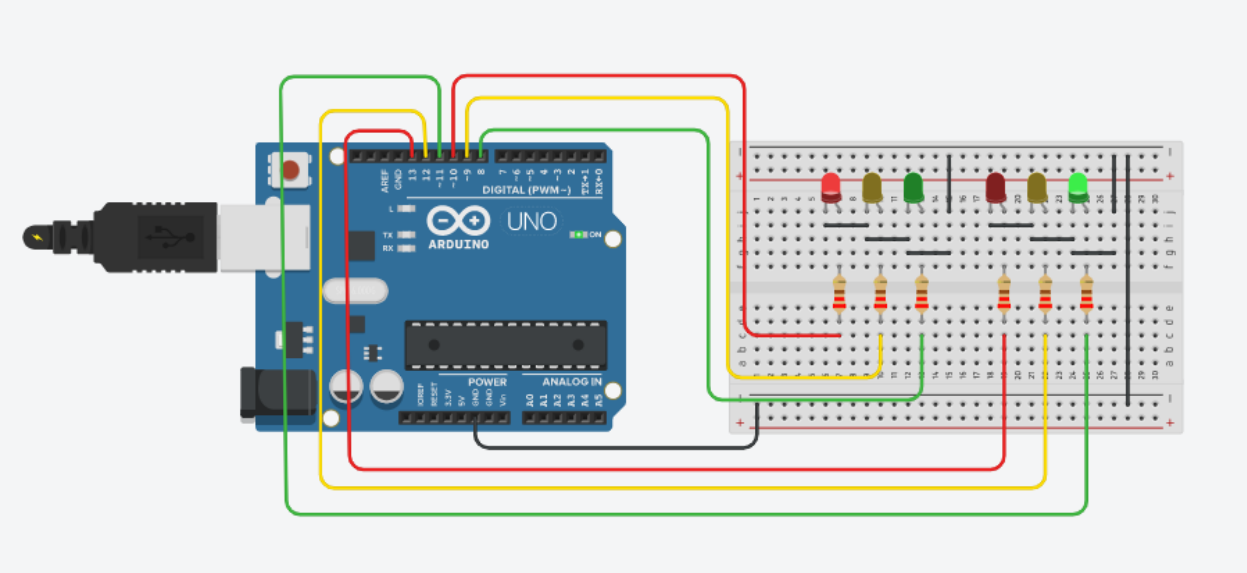
To verify the working of the 2-way traffic light system which controls the flow of traffic, tinkercad is being used with one arduino, a small breadboard and 6 LEDs that vary with 3 different colours representing the traffic light. The set-up of this project in Tinkercad is shown below.



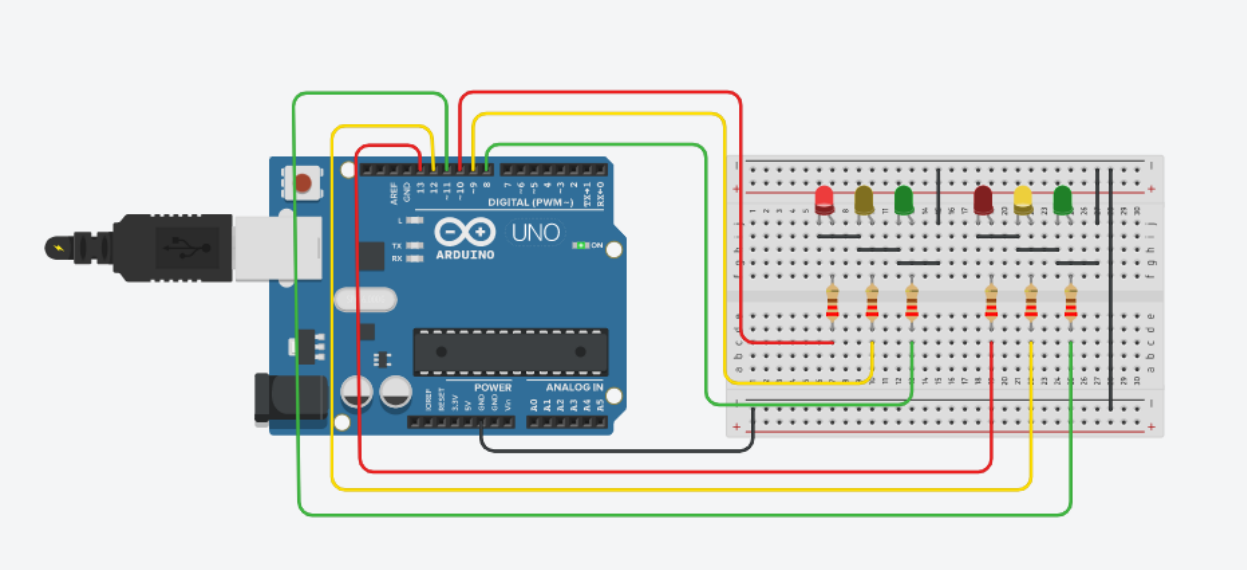
First, the program will start with the condition where both red colour LEDs are HIGH. This is the order when pedestrians can walk across the pedestrian lane to go to the other side.



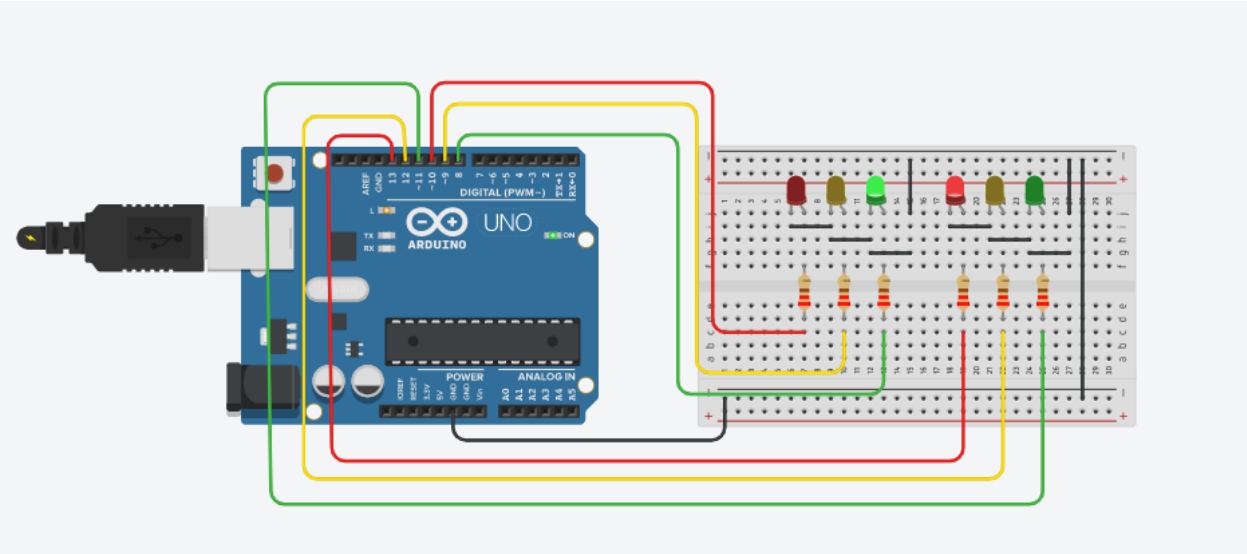
Then, the green LED for the second traffic light will light up in which it indicates the car can move unlike the opposite side.



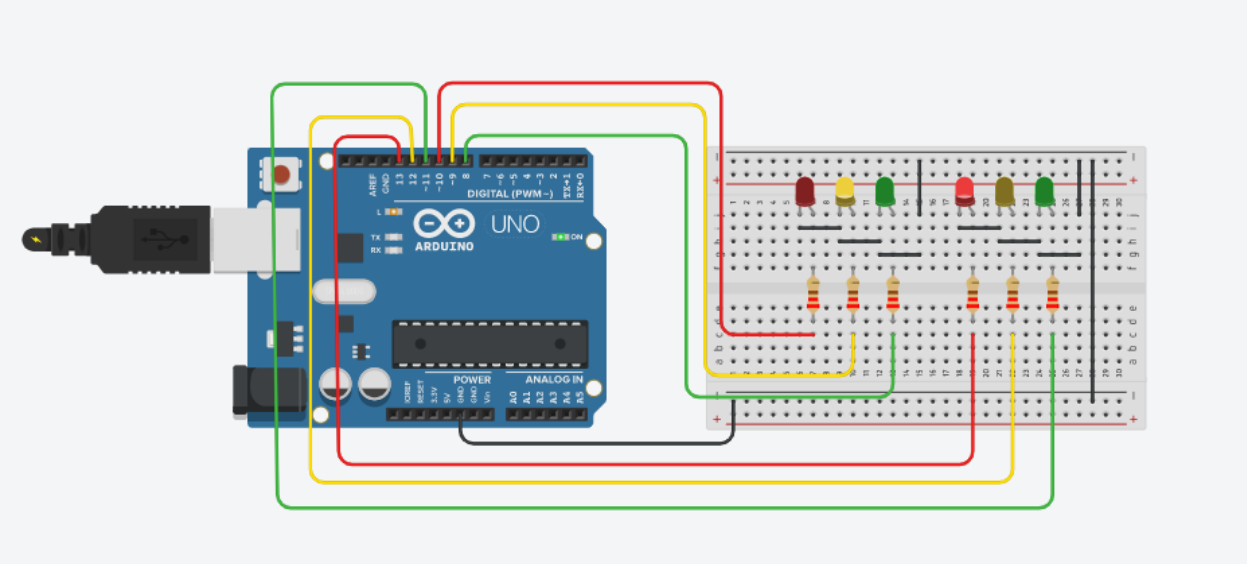
Next, for about 3 seconds, the yellow LED will appear on the second traffic light to depict that we have to prepare to stop. If you have already crossed the stop line when the yellow light appears or are positioned close to the stop line where stopping may be dangerous, you should proceed.



Furthermore, the red LED for both traffic lights will again occur to allow the pedestrians crossing the road. After the road in the second traffic light is clear, the green LED in the first traffic light will go HIGH and the cars are safe to go while the red LED in the second traffic light continues LOW.



After that, the yellow LED in the first traffic light will then go high around 3 seconds to prepare the car to stop moving along the road.



Lastly, the cycle will continue looping and allowing the cars to move around without causing any accident scene.

Coding in Tinkercad

```
// traffic light one
int R1 = 10;
int Y1 = 9;
int G1 = 8;

// traffic light two
int R2 = 13;
int Y2 = 12;
int G2 = 11;

void setup()
{
    // traffic light one
    pinMode(R1, OUTPUT);
    pinMode(Y1, OUTPUT);
    pinMode(G1, OUTPUT);

    // traffic light two
    pinMode(R2, OUTPUT);
    pinMode(Y2, OUTPUT);
    pinMode(G2, OUTPUT);
}
void loop()
{
    changeLights();
    delay(1000);
}
void changeLights()
{
   // turn both reds on
   digitalWrite(R1, HIGH);
   digitalWrite(R2, HIGH);
   digitalWrite(Y1, LOW);
   digitalWrite(Y2, LOW);
   digitalWrite(G1, LOW);
   digitalWrite(G2, LOW);
   delay(5000);

   // turn on second traffic light green, and keep the same for
   //first traffic light
   digitalWrite(R1, HIGH);
   digitalWrite(R2, LOW);
   digitalWrite(Y1, LOW);
   digitalWrite(Y2, LOW);
   digitalWrite(G1, LOW);
   digitalWrite(G2, HIGH);
   delay(5000);

   // turn on second traffic light yellow, and keep the same for
   //first traffic light
   digitalWrite(R1, HIGH);
   digitalWrite(R2, LOW);
   digitalWrite(Y1, LOW);
   digitalWrite(Y2, HIGH);
   digitalWrite(G1, LOW);
   digitalWrite(G2, LOW);
```

```
58
59      // turn both reds on
60      digitalWrite(R1, HIGH);
61      digitalWrite(R2, HIGH);
62      digitalWrite(Y1, LOW);
63      digitalWrite(Y2, LOW);
64      digitalWrite(G1, LOW);
65      digitalWrite(G2, LOW);
66      delay(5000);
67
68      // turn on first traffic light green, and keep the same for
69      //second traffic light
70      digitalWrite(R1, LOW);
71      digitalWrite(R2, HIGH);
72      digitalWrite(Y1, LOW);
73      digitalWrite(Y2, LOW);
74      digitalWrite(G1, HIGH);
75      digitalWrite(G2, LOW);
76      delay(5000);
77
78      // turn on first traffic light yellow, and keep the same for
79      //second traffic light
80      digitalWrite(R1, LOW);
81      digitalWrite(R2, HIGH);
82      digitalWrite(Y1, HIGH);
83      digitalWrite(Y2, LOW);
84      digitalWrite(G1, LOW);
85      digitalWrite(G2, LOW);
86      delay(3000);
87
88  }
```

Link for Tinkercad:

https://www.tinkercad.com/things/d5XrKJRpqBt-super-esboo-uusam/editel?sharecode=zvQERAxbZqkv2hP9uyA4aA-_QnqJwKbxdFLERsDloDU

5.0 CONCLUSION

The aim of this project is to develop a system that automatically manages the flow of traffic at junctions by alternating the priority with which vehicles may proceed first. This enables vehicles to flow freely from one direction, while vehicles coming from another direction are kept back in order to wait for their turn. Drivers must cautiously approach the traffic light junctions while preparing for the lights to turn another colour. Other than that, it is also developed to maintain the peaceful environment and prevent any accident from occurring, ultimately keeping our roads safer. The application of flip flops and many types of logic gates used in this project helps in building the system. The D flip flops that are used is to make sure the system operates in sequence and in order. The verification of the system using Tinkercad neatly shows the operation of it. Thus, the learning throughout this semester has been implemented and evaluated successfully as the system running accordingly with the goal of this project. As this system is already built in the real world, the number of cases related to car accidents slowly decreased day by day. Despite this, humans can move from one place to another without worrying about their safety with the presence of this system. I believe that with this 2-way traffic light system, together we can create a better environment in the community. Hence, we may say that the objectives of our projects are achieved.