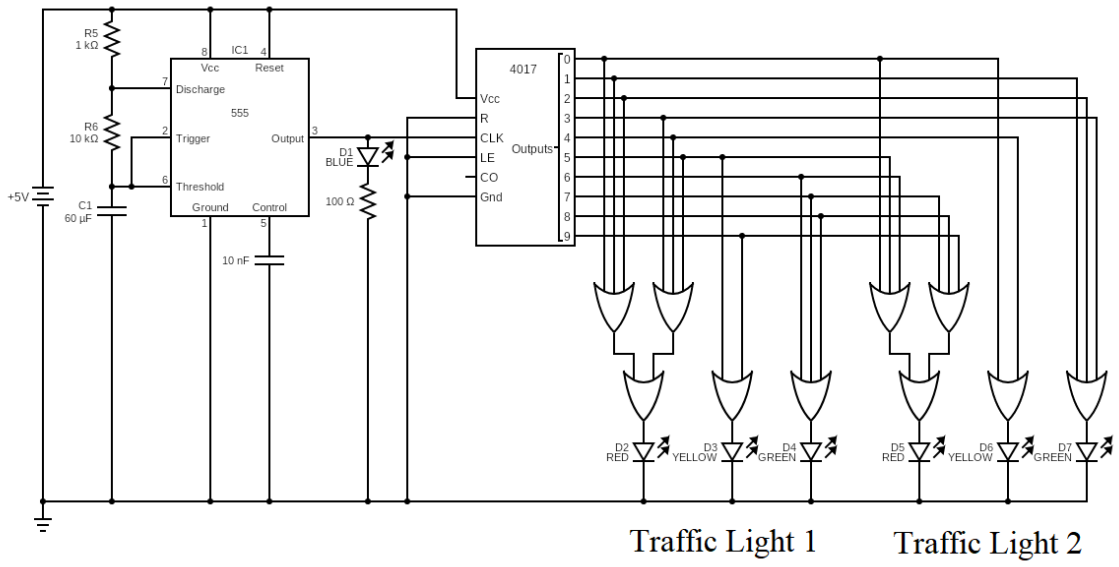
Objective

The purpose of this project is to design a working prototype of a two-way traffic light. A traffic light consists of red, yellow, and green lights. A two-way traffic light consists of two sets of traffic lights, such that when one set is showing the red signal, the other shows green, and vice versa. A two-way traffic light can be used in intersections, when the traffic coming from two roads is to be regulated.

Components Required

Sr. No.	Components
1.	5V Battery
2.	3 Resistors (100 Ω, 1 kΩ, 10 kΩ)
3.	2 Capacitors (60 µF, 0.01 µF)
4.	7 LEDs (2 Red, 2 Yellow, 2 Green, 1 Blue)
5.	2 7432 ICs (2-input OR Gate)
6.	2 4072 ICs (4-input OR Gate)
7.	555 Timer IC
8.	CD4017 (Johnson Decade Counter with Decoded Outputs)

Circuit Diagram



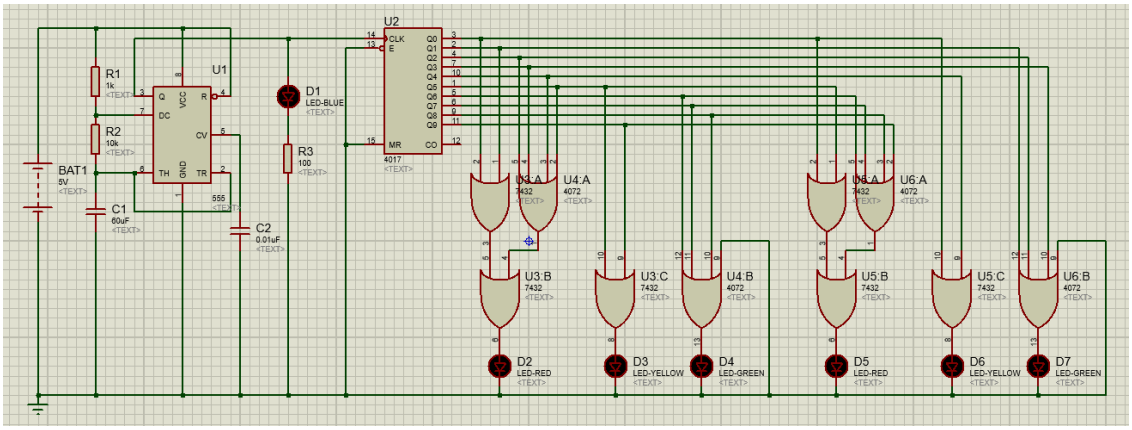
Working Principle:

i. The working of the two-way traffic light is solely dependent upon a decade counter.
ii. The decade counter receives a continuous clock signal as input. This clock signal is generated with the help of a 555 timer, two resistors, and one capacitor. The frequency and duty cycle of the clock signal is determined by the resistors and capacitors. Here the 555 timer is called “astable multivibrator”.
iii. The decade counter has 10 outputs, numbered from 0 to 9. The outputs are such that only one out of the 10 output pins is high at any point of time, while the others are low. Each time the clock signal becomes high, the pins 0 to 9 become high successively – in other words, the output goes from 0000000001, 0000000010, 0000000100…, 1000000000.
iv. These outputs are then fed to a few OR gates, which are then fed to the LED lights. The role of the OR gates is to ensure that the LED lights remain ON for a specific period of time and maintain the right sequence (red → yellow → green → yellow → red →…).
v. The following table shows which lights are ON when each of the outputs 0 to 9 are high:

Traffic Light | Output that is high ↓ →	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Traffic Light 1	R	R	R	R	R	R, Y	G	G	G	Y
Traffic Light 2	R, Y	G	G	G	Y	R	R	R	R	R

From the above table it can be observed that when one traffic light transitions from red to green, the other traffic light transitions from green to red, and vice versa.

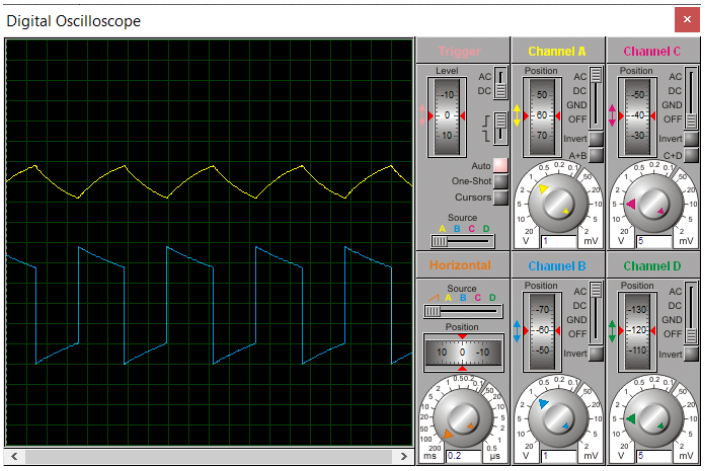
Proteus Circuit Diagram & Simulation



The simulation works according to the working principle. Diode D1, a blue LED, indicates the clock signal by switching on and off with each pulse. Diodes D2, D3 and D4 are the red, yellow and green LEDs of the first traffic light, while D5, D6 and D7 are the LEDs of the second traffic light.

Waveforms

i. Input and output waveforms of 555 Timer.



The first, yellow graph shows the charging and discharging of the capacitor C_1. The voltage across C_1 is the input to Threshold and Trigger pins of 555 Timer. C_1 charges through the resistors R_1 and R_2 until it reaches a voltage (2/3)VCC or 3.33 V, and discharges through the resistor R_2, until it reaches a voltage (1/3)VCC or 1.67 V.

The second, blue graph is the output of the 555 Timer. When C_1 charges, the output is high, and when it discharges, the output is low. It was observed that the high and low values of the output square wave were 4.75 V and 0 V respectively. T_1 refers to high time, and T_2 refers to low time. T_1 depends on R_1, R_2, C_1, while T_2 is depends on R_2, C_1. The total time period, T, is the sum of T_1 and T_2. The "duty cycle" of the signal refers to the ratio of T_1 to T, represented in the form of a percentage:

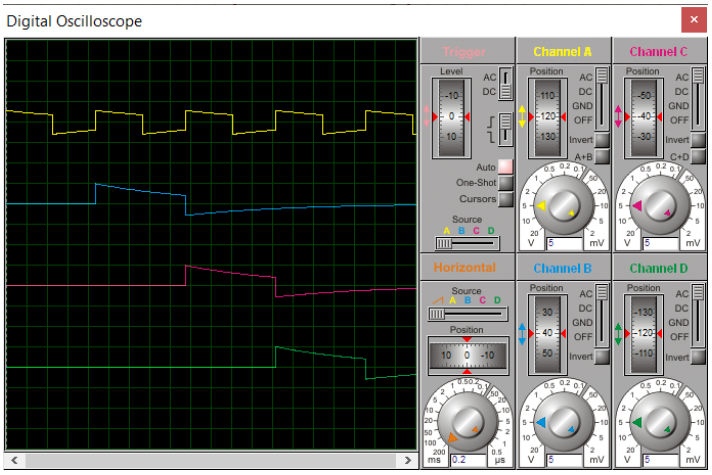
$$T_1 = 0.693(R_1 + R_2)C_1 = 0.458\ s$$

$$T_2 = 0.693 \times R_2 \times C_1 = 0.416\ s$$

$$T = T_1 + T_2 = 0.874\ s$$

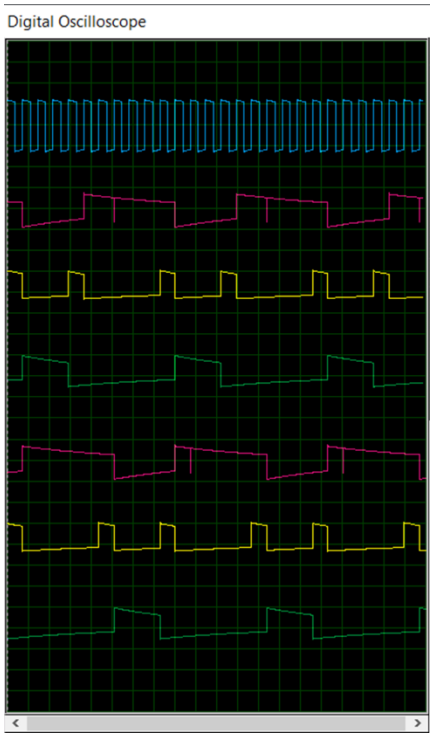
$$Duty\ Cycle = \frac{R_1 + R_2}{R_1 + 2R_2} = 52.38\%$$

ii. Input and output waveforms of CD4017 Decade Counter:



In the above image, the first, yellow graph is the input clock signal from 555 Timer. The second, blue graph is the first output of the decade counter, 0 or Q_0. The pink graph is the output 1 or Q_1, and the green graph is the output 2 or Q_2. For the first clock cycle, the output Q_0 is high, then becomes low. In the next clock cycle, output Q_1 is high, then becomes low. After this clock cycle, output Q_2 is high then becomes low. In this manner, the outputs Q_0 to Q_9 cycle from 0000000001 to 1000000000.

iii. Traffic Light Waveforms



The first blue graph is the clock signal. The first set of red, yellow and green graphs represents the waveforms of first traffic light. Similarly, the second set represents the waveforms of the second traffic light. It can be seen that when first traffic light is red, the second is green, and vice versa. Further, it can be observed that the second light transitions from red to yellow only when the first light becomes fully red. Similarly,

first light transitions from red to yellow only when the second light becomes fully red. This increases the safety in the road, since some cars will still be moving during the yellow light.

Result & Conclusion

The two-way traffic light was implemented successfully using 555 Timer and Decade Counter. The waveform of the traffic light shows that when one traffic light is red, the other is green, and vice versa. Further, it shows that both traffic lights follow the proper sequence of switching of lights. Hence, the working of the two-way traffic light is verified. The efficiency of the two-way traffic light can be increased by using microprocessors.

Discussion About the Project

We chose this project to better understand the working of 555 Timer and Decade Counter, and to understand the range of applications for which Decade Counter can be used. Initially we only implemented a one-way traffic light. Upon better understanding the working of the one-way traffic light, we were able to modify the circuit, adding OR gates, in order to accommodate another set of traffic lights. Further, we had to think about how to connect the LED lights to the OR gates such that the two traffic lights do not conflict with each other, while simultaneously accommodating the functioning of both traffic lights within 10 clock pulses.