# EMBEDDED SYSTEMS
## PROJECT


## TRAFFIC LIGHTS SIMULATOR using ARDUINO


## GROUP - 16


CED17I004
CED17I023
CED17I031
CED17I034
CED17I035

**CONTRIBUTION**

**AUTODESK TINKERCAD MODEL -** CED17I004, CED17I031


**ARDUINO CODE -** CED17I023, CED17I034


**TIVAC CODE -** CED17I004, CED17I035


**DOCUMENTATION -** CED17I004, CED17I023, CED17I031, CED17I034, CED17I035


**<u>TRAFFIC LIGHT:</u>** A road signal for directing vehicular traffic by means of colored lights, typically red for stop, green for go, and yellow for proceed with caution. Also called a stoplight, *traffic signal*.

**First ever traffic light:** the world's first traffic light was a manually operated gas-lit signal installed in London in December 1868. It exploded less than a month after it was implemented, injuring its policeman operator.] Earnest Sirrine from Chicago patented the first automated traffic control system in 1910. It used the words "STOP" and "PROCEED", although neither word was illuminated.

## UNIVERSAL COLOR CODE:

Traffic lights follow a universal colour code which alternates the right of way accorded to users with a sequence of illuminating lamps or LEDs of three standard colours:

- **Green light**
  Allows traffic to proceed in the direction denoted, if it is safe to do so and there is room on the other side of the intersection. The green light was traditionally green in colour (hence its name) though modern LED green lights are turquoise.

- **Red light**
  Prohibits any traffic from proceeding. A flashing red indication requires traffic to stop and then proceed when safe (equivalent to a stop sign).

- **Amber light** (also known as 'yellow light')
  Warns that the signal is about to change to red, with some jurisdictions requiring drivers to stop if it is safe to do so, and others allowing drivers to go through the intersection if safe to do so. In some European countries (such as the UK), red and amber is displayed together, indicating that the signal is about to change to green.

## TRAFFIC LIGHTS AT A 4-JUNCTION:

- We have considered the case of a 4-junction and have implemented the traffic light system in two different ways:
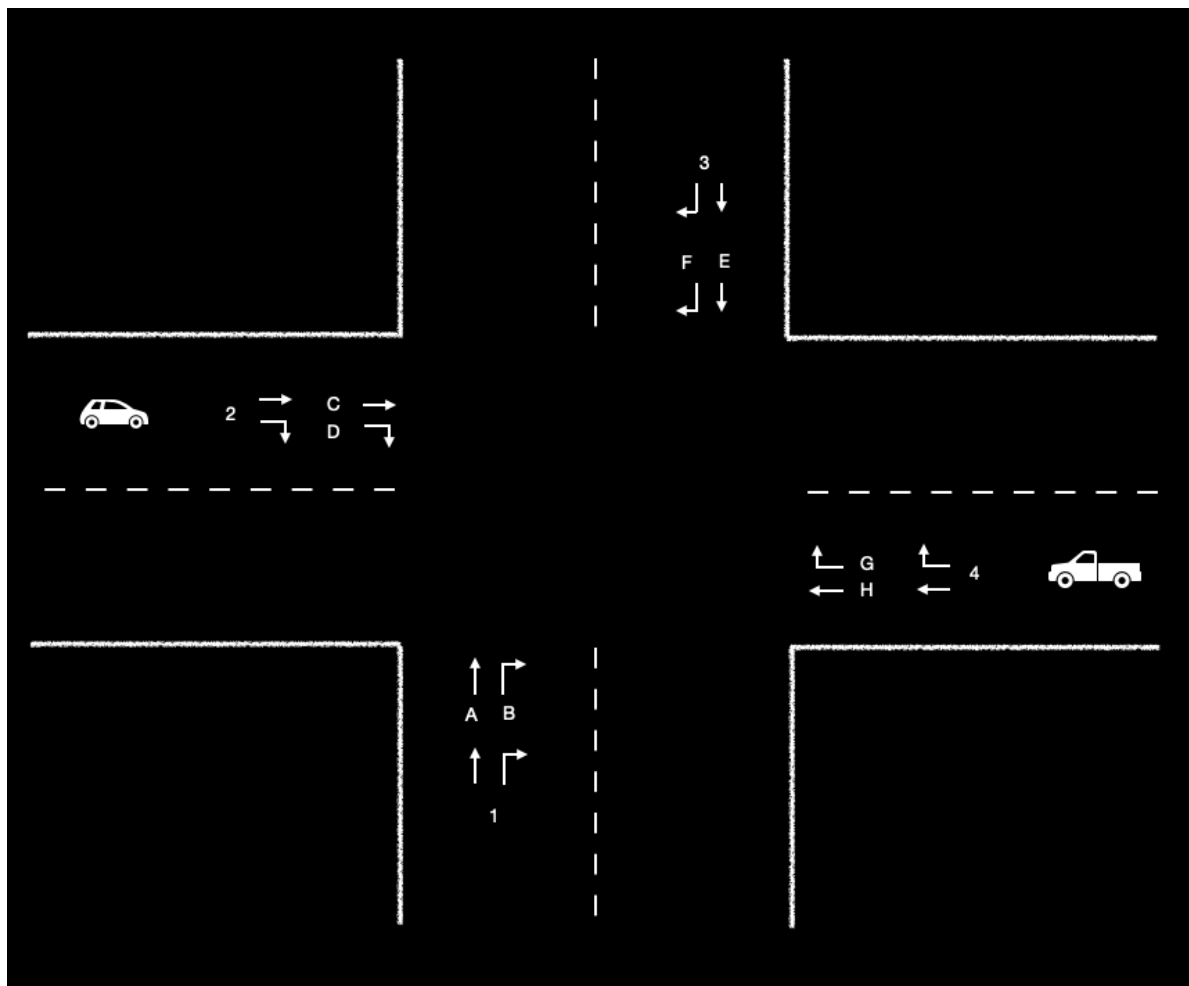
- Method A
- Method B



**Fig. 1**

- **Both of these methods have been implemented considering the indian traffic rules.**

## METHOD A:

- This method is a much more simpler method compared to the other one.

- In this method, we consider the signal for going straight and right as a single signal.

- So a green signal in this method would mean that the driver is free to go straight and right, keeping in mind that going left is free in the indian traffic system.

- **Color code:**



**Red** means stop. Wait behind the stop line.
Do not go through the intersection.



**Yellow (amber)** means stop.
You can enter the intersection if you are so close that sudden braking might cause a crash.



**Green** means proceed through the intersection carefully.

- The number of cases in this method are : 5

- This kind of technique can be implemented in an area where the traffic densities are low, like in rural areas.

## METHOD B :

- This method is much more complex compared to the previous method.

- In this method we consider two different signals for straight and right, unlike the previous method. This would mean an extra signal at each point of the

intersection.

- **Color code:**

**Red** means stop. Wait behind the stop line.
Do not go through the intersection.

**Yellow (amber)** means stop.
You can enter the intersection if you are so close that sudden braking might cause a crash.

**Green** means proceed through the intersection carefully.

You must not go straight ahead or turn left. You may turn right.

You must not turn right but you can go straight ahead or turn left if the way is clear.

When the yellow (amber) arrow is flashing, you may proceed but you must give way to any pedestrian who is crossing the road into which you are turning.

- The number of cases in this method are : 5
- This kind of technique can be implemented in an area where the traffic densities are high, like in urban areas.

- Additionally we have included a signal for the pedestrian crossing:



*Pedestrians must not start to cross*
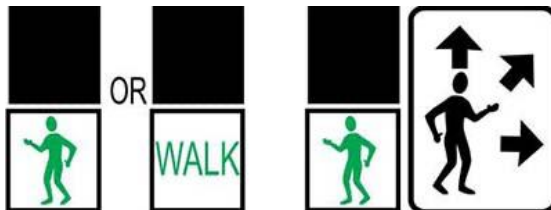


*Pedestrians may start to cross.*

## CASES INVOLVED IN METHOD A:

- Equal distribution for all roads at the intersection.

- Each signal could last from 30 seconds to 4 minutes, depending on the traffic density in that place at that time.

- When the signal for a point is green, the signal for the rest of the points at the intersection is red.

Case A:
 1 - red
 2 - red
 3 - red
 4 - red

Case B:
 1 - green
 2 - red
 3 - red
 4 - red

Case C:
 1 - red
 2 - green
 3 - red
 4 - red

Case D:
 1 - red
 2 - red
 3 - green
 4 - red

Case E:
 1 - red
 2 - red
 3 - red
 4 - green

## CASES INVOLVED IN METHOD B:
 ● Equal distribution for all roads at the intersection.

 ● Each signal could last from 30 seconds to 4 minutes, depending on the traffic density in that place at that time.

 ● These 8 cases have been compressed to 4 cases for better code readability.

 ● When the signal for a point is green to go straight, the signal to go right for the point to the right of the previous one would also be green .

- After a while, the signal to the right for the other point is stopped and the present point would be given a complete green signal.

Case 1:
      A - red
      B - red
      C - red
      D - red
      E - red
      F - red
      G - red
      H - red

Case 2:
      A - green
      B - red
      C - red
      D - red
      E - red
      F - red
      G - green
      H - red

Case 3:
      A - green
      B - green
      C - red
      D - red
      E - red
      F - red
      G - red
      H - red

Case 4:
      A - red

B - green
C - green
D - red
E - red
F - red
G - red
H - red

Case 5:
A - red
B - red
C - green
D - green
E - red
F - red
G - red
H - red

Case 6:
A - red
B - red
C - red
D - green
E - green
F - red
G - red
H - red

Case 7:
A - red
B - red
C - red
D - red
E - green
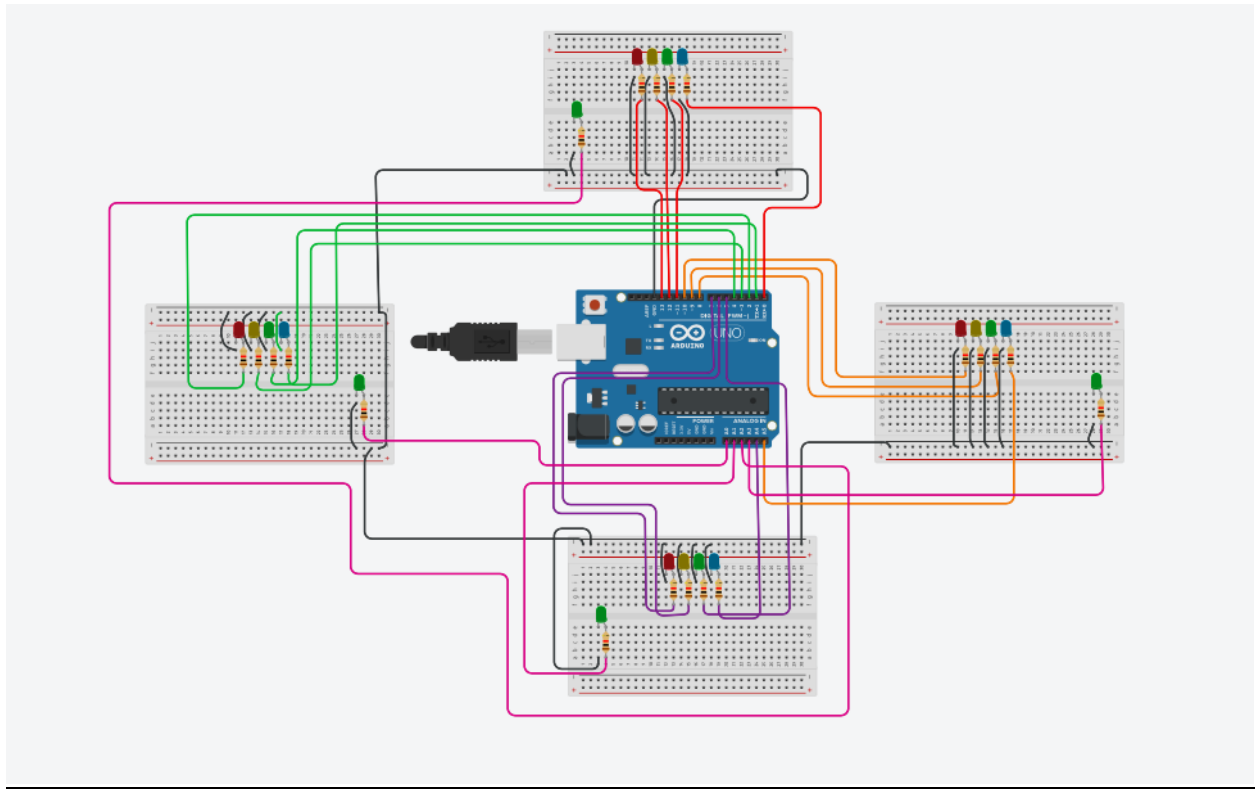F - green
G - red
H - red

Case 8:
A - red
B - red
C - red
D - red

E - red
F - green
G - red
H - green

## **COMPONENTS REQUIRED TO IMPLEMENT THIS USING ARDUINO:**

- Arduino Uno R3          x1
- Yellow LED               x4
- Green LED                x8
- Red LED                  x4
- Blue LED                 x4
- Jumper Wires
- Resistors                x20
- Bread Boards             x4

## **CIRCUIT:**

**Working of the code:**
https://drive.google.com/file/d/1xafKpPSGk8P3K4kj0G7FfMpW2mEwgmMM/view?usp=sharing

**CODE:**

```
int count = 1;
int mode = 0;
void setup()
{
  pinMode(13, OUTPUT);
  pinMode(12, OUTPUT);
  pinMode(11, OUTPUT);
  pinMode(10, OUTPUT);

  pinMode(9, OUTPUT);
  pinMode(8, OUTPUT);
  pinMode(7, OUTPUT);
  pinMode(6, OUTPUT);

  pinMode(5, OUTPUT);
  pinMode(4, OUTPUT);
  pinMode(3, OUTPUT);
  pinMode(2, OUTPUT);

  pinMode(1, OUTPUT);
  pinMode(0, OUTPUT);
  pinMode(A5, OUTPUT);
  pinMode(A4, OUTPUT);

  pinMode(A3, OUTPUT);
  pinMode(A2, OUTPUT);
  pinMode(A1, OUTPUT);
  pinMode(A0, OUTPUT);

}
```

- Variables count and mode have been set to 1 and 0 respectively.

- **setup() -** The setup() function is called when a sketch starts. Use it to initialize variables, pin modes, start using libraries, etc. The setup() function will only run once, after each powerup or reset of the Arduino board**.**

- **pinMode()** - Configures the specified pin to behave either as an input or an output. Syntax - pinMode(pin, mode)

- We have declared Digital ports 0 - 13, and Analogo ports A0 - A5 as OUTPUT. Each LED has been connected to an individual port.

```
void loop()
{
  if( mode == 0)
  {
  if(count == 1)
  {

  //case-1

    digitalWrite(13, HIGH);
    digitalWrite(10, HIGH);
    digitalWrite(7, HIGH);
    digitalWrite(2, HIGH);

    delay(3000);

    digitalWrite(6, HIGH);
    delay(300);
    digitalWrite(6, LOW);
    delay(300);
    digitalWrite(6, HIGH);
    delay(300);
    digitalWrite(6, LOW);
    delay(300);
    digitalWrite(6, HIGH);
    delay(300);
    digitalWrite(6, LOW);
    delay(300);



    count++;

  }
```

## METHOD - A, CASE - A:

- **loop ()** - After creating a setup() function, which initializes and sets the initial values, the loop() function does precisely what its name suggests, and loops consecutively, allowing your program to change and respond. Use it to actively control the Arduino board.

- **digital.Write () -** Write a HIGH or a LOW value to a digital pin. If the pin has been configured as an OUTPUT with pinMode(), its voltage will be set to the corresponding value: 5V (or 3.3V on 3.3V boards) for HIGH, 0V (ground) for LOW.

- Signals at road 1, 2, 3, 4 are all red.

- After a delay of 3 seconds, Yellow at road 1 is blinked to indicate that it is going to change signal next.

- Count is incremented, so that it can move to the next case.

```
else if(count == 2)
{

//case-2

  digitalWrite(7, LOW);
  digitalWrite(13, HIGH);
  digitalWrite(10, HIGH);
  digitalWrite(5, HIGH);
  digitalWrite(2, HIGH);

  delay(3000);


  digitalWrite(5, LOW);


  delay(1000);

  digitalWrite(6, HIGH);
  digitalWrite(3, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(3, LOW);
  delay(300);
  digitalWrite(6, HIGH);
  digitalWrite(3, HIGH);
delay(300);
  digitalWrite(6, LOW);
  digitalWrite(3, LOW);
  delay(300);
  digitalWrite(6, HIGH);
  digitalWrite(3, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(3, LOW);
  delay(300);




  count++;
}
```

## METHOD - A, CASE - B:

- Red signal of road 1 is turned off, and the green signal is turned on.

- After a delay of 3 seconds, Yellow signals at road 1 and 2 are blinked to indicate that they are going to change signal next.

- Count is incremented, so that it can move to the next case.

```
else if(count == 3)
{

//case-3
  digitalWrite(2, LOW);
  digitalWrite(13, HIGH);
  digitalWrite(10, HIGH);
  digitalWrite(7, HIGH);
  digitalWrite(4, HIGH);

  delay(3000);


  digitalWrite(4, LOW);

  delay(1000);

  digitalWrite(3, HIGH);
  digitalWrite(12, HIGH);
  delay(300);
  digitalWrite(3, LOW);
  digitalWrite(12, LOW);
  delay(300);
  digitalWrite(3, HIGH);
  digitalWrite(12, HIGH);
  delay(300);
  digitalWrite(3, LOW);
  digitalWrite(12, LOW);
  delay(300);
  digitalWrite(3, HIGH);
  digitalWrite(12, HIGH);
  delay(300);
  digitalWrite(3, LOW);
  digitalWrite(12, LOW);
  delay(300);

  count++;
}
```

## METHOD - A, CASE - C:

- Red signal of road 2 is turned off, and the green signal is turned on.

- Green signal of road 1 is turned off, and the red signal is turned on.

- After a delay of 3 seconds, Yellow signals at road 2 and 3 are blinked to indicate that they are going to change signal next.

- Count is incremented, so that it can move to the next case.

```
  else if(count == 4)
{

//case-4
  digitalWrite(13, LOW);
  digitalWrite(11, HIGH);
  digitalWrite(10, HIGH);
  digitalWrite(7, HIGH);
  digitalWrite(2, HIGH);

  delay(3000);

  digitalWrite(11, LOW);


  delay(1000);

  digitalWrite(12, HIGH);
  digitalWrite(9, HIGH);
  delay(300);
  digitalWrite(12, LOW);
  digitalWrite(9, LOW);
  delay(300);
  digitalWrite(12, HIGH);
  digitalWrite(9, HIGH);
  delay(300);
  digitalWrite(12, LOW);
  digitalWrite(9, LOW);
  delay(300);
  digitalWrite(12, HIGH);
  digitalWrite(9, HIGH);
  delay(300);
  digitalWrite(12, LOW);
  digitalWrite(9, LOW);
  delay(300);

  count++;
}
```

## METHOD - A, CASE - D:

- Red signal of road 3 is turned off, and the green signal is turned on.

- Green signal of road 2 is turned off, and the red signal is turned on.

- After a delay of 3 seconds, Yellow signals at road 3 and 4 are blinked to indicate that they are going to change signal next.

- Count is incremented, so that it can move to the next case.

```
    else if(count == 5)
{

//case-5

    digitalWrite(10, LOW);
    digitalWrite(13, HIGH);
    digitalWrite(8, HIGH);
    digitalWrite(7, HIGH);
    digitalWrite(2, HIGH);

    delay(3000);


    digitalWrite(8, LOW);


    delay(1000);

    digitalWrite(9, HIGH);
    delay(300);
    digitalWrite(9, LOW);
    delay(300);
    digitalWrite(9, HIGH);
    delay(300);
    digitalWrite(9, LOW);
    delay(300);
    digitalWrite(9, HIGH);
    delay(300);
    digitalWrite(9, LOW);
    delay(300);


    mode++;
    count = 1;

}

}
```

## METHOD - A, CASE - E:

- Red signal of road 4 is turned off, and the green signal is turned on.

- Green signal of road 3 is turned off, and the red signal is turned on.

- After a delay of 3 seconds, Yellow signal at road 4 is blinked to indicate that it is going to change signal next.

- Mode is incremented, so that it can move to the next Method.

```
else
{

if(count == 1)
{

//case-1

  digitalWrite(13, HIGH);
  digitalWrite(10, HIGH);
  digitalWrite(7, HIGH);
  digitalWrite(2, HIGH);
  digitalWrite(A0, HIGH);
  digitalWrite(A1, HIGH);
  digitalWrite(A2, HIGH);
  digitalWrite(A3, HIGH);
  delay(3000);
  digitalWrite(A0, HIGH);
  digitalWrite(A1, HIGH);
  digitalWrite(A2, HIGH);
  digitalWrite(A3, HIGH);
  delay(300);
  digitalWrite(A0, LOW);
  digitalWrite(A1, LOW);
  digitalWrite(A2, LOW);
  digitalWrite(A3, LOW);
  delay(300);
  digitalWrite(A0, LOW);
  digitalWrite(A1, LOW);
  digitalWrite(A2, LOW);
  digitalWrite(A3, LOW);
  delay(300);
  digitalWrite(A0, HIGH);
  digitalWrite(A1, HIGH);
  digitalWrite(A2, HIGH);
  digitalWrite(A3, HIGH);
  delay(300);
  digitalWrite(A0, LOW);
  digitalWrite(A1, LOW);
  digitalWrite(A2, LOW);
  digitalWrite(A3, LOW);
  delay(300);
  digitalWrite(A0, HIGH);
  digitalWrite(A1, HIGH);
  digitalWrite(A2, HIGH);
  digitalWrite(A3, HIGH);
  delay(300);
  digitalWrite(A0, LOW);
  digitalWrite(A1, LOW);
  digitalWrite(A2, LOW);
  digitalWrite(A3, LOW);
  delay(300);

  count++;

}
```

## METHOD - B, CASE - A:

- Signals at road 1, 2, 3, 4 are all red and all pedestrian signals are green.

- Red signals at all roads are blinked to indicate they are going to change next.

- Count is incremented, so that it can move to the next case.

- Blue LEDs are used to indicate that they must not go straight ahead or turn left. They may turn right.

- Green LEDs are used to indicate that they must not turn right or turn left. They may go straight ahead.

- Count is incremented, so that it can move to the next case.

```
else if(count == 2)
{

//case-2
  digitalWrite(A0, HIGH);
  digitalWrite(7, HIGH);
  digitalWrite(13, HIGH);
  digitalWrite(10, HIGH);
  digitalWrite(5, HIGH);
  digitalWrite(A5, HIGH);
  digitalWrite(2, HIGH);

  delay(3000);

  digitalWrite(6, HIGH);
  digitalWrite(9, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(9, LOW);
  delay(300);
  digitalWrite(6, HIGH);
  digitalWrite(9, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(9, LOW);
  delay(300);
  digitalWrite(6, HIGH);
  digitalWrite(9, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(9, LOW);
  delay(300);

  digitalWrite(7, LOW);
  digitalWrite(A5, LOW);
  digitalWrite(A4, HIGH);

  delay(3000);
  digitalWrite(6, HIGH);
  digitalWrite(3, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(3, LOW);
  delay(300);
  digitalWrite(6, HIGH);
  digitalWrite(3, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(3, LOW);
  delay(300);
  digitalWrite(6, HIGH);
  digitalWrite(3, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(3, LOW);
  delay(300);

  digitalWrite(A0, LOW);




  count++;
}
```

**METHOD - B, CASE - B:**
- Green and Blue signals at road 1 and 4 respectively are turned on.

- After a delay of 3 seconds, Yellow signals at road 1 and 4 are blinked to indicate that they are going to change signal next.

- Green and Blue signals at road 1 are turned on, Blue signal at road 4 is turned off.

- After a delay of 3 seconds, Yellow signals at road 1 and 4 are blinked to indicate that they are going to change signal next.

- Count is incremented, so that it can move to the next case.

```
else if(count == 3)
{

//case-3
  digitalWrite(A2, HIGH);
  digitalWrite(5, LOW);
  digitalWrite(13, HIGH);
  digitalWrite(10, HIGH);
  digitalWrite(7, HIGH);
  digitalWrite(4, HIGH);
  digitalWrite(2, HIGH);


  delay(3000);

  digitalWrite(6, HIGH);
  digitalWrite(3, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(3, LOW);
  delay(300);
  digitalWrite(6, HIGH);
  digitalWrite(3, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(3, LOW);
  delay(300);
  digitalWrite(6, HIGH);
  digitalWrite(3, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(3, LOW);
  delay(300);
```

```
  digitalWrite(A4, LOW);
  digitalWrite(1, HIGH);
  digitalWrite(2, LOW);
  delay(3000);

  digitalWrite(3, HIGH);
  digitalWrite(12, HIGH);
  delay(300);
  digitalWrite(3, LOW);
  digitalWrite(12, LOW);
  delay(300);
  digitalWrite(3, HIGH);
  digitalWrite(12, HIGH);
  delay(300);
  digitalWrite(3, LOW);
  digitalWrite(12, LOW);
  delay(300);
  digitalWrite(3, HIGH);
  digitalWrite(12, HIGH);
  delay(300);
  digitalWrite(3, LOW);
  digitalWrite(12, LOW);
  delay(300);

  digitalWrite(A2, LOW);
  count++;
}
```

## METHOD - B, CASE - C:

- Green and Blue signals at road 2 and 1 respectively are turned on.

- After a delay of 3 seconds, Yellow signals at road 1 and 2 are blinked to indicate that they are going to change signal next.

- Green and Blue signals at road 2 are turned on, Blue signal at road 1 is turned off.

- After a delay of 3 seconds, Yellow signals at road 2 and 3 are blinked to indicate that they are going to change signal next.

- Count is incremented, so that it can move to the next case.

```
    else if(count == 4)
    {

//case-4
    digitalWrite(A3, HIGH);
    digitalWrite(4, LOW);
    digitalWrite(13, HIGH);
    digitalWrite(11, HIGH);
    digitalWrite(10, HIGH);
    digitalWrite(7, HIGH);
    digitalWrite(2, HIGH);

    delay(3000);

    digitalWrite(3, HIGH);
    digitalWrite(12, HIGH);
    delay(300);
    digitalWrite(3, LOW);
    digitalWrite(12, LOW);
    delay(300);
    digitalWrite(3, HIGH);
    digitalWrite(12, HIGH);
    delay(300);
    digitalWrite(3, LOW);
    digitalWrite(12, LOW);
    delay(300);
    digitalWrite(3, HIGH);
    digitalWrite(12, HIGH);
    delay(300);
    digitalWrite(3, LOW);
    digitalWrite(12, LOW);
    delay(300);
```

```
    digitalWrite(1, LOW);
    digitalWrite(13, LOW);
    digitalWrite(0, HIGH);
    delay(3000);

    digitalWrite(9, HIGH);
    digitalWrite(12, HIGH);
    delay(300);
    digitalWrite(9, LOW);
    digitalWrite(12, LOW);
    delay(300);
    digitalWrite(9, HIGH);
    digitalWrite(12, HIGH);
    delay(300);
    digitalWrite(9, LOW);
    digitalWrite(12, LOW);
    delay(300);
    digitalWrite(9, HIGH);
    digitalWrite(12, HIGH);
    delay(300);
    digitalWrite(9, LOW);
    digitalWrite(12, LOW);
    delay(300);
    digitalWrite(A3, LOW);
    count++;
    }
```

## METHOD - B, CASE - D:

- Green and Blue signals at road 3 and 2 respectively are turned on.

- After a delay of 3 seconds, Yellow signals at road 3 and 2 are blinked to indicate that they are going to change signal next.

- Green and Blue signals at road 3 are turned on, Blue signal at road 2 is turned off.

- After a delay of 3 seconds, Yellow signals at road 3 and 4 are blinked to indicate that they are going to change signal next.

- Count is incremented, so that it can move to the next case.

```
  else if(count == 5)
{

//case-5
  digitalWrite(A1, HIGH);
  digitalWrite(11, LOW);
  digitalWrite(10, HIGH);
  digitalWrite(13, HIGH);
  digitalWrite(8, HIGH);
  digitalWrite(7, HIGH);
  digitalWrite(2, HIGH);

  delay(3000);

  digitalWrite(12, HIGH);
  digitalWrite(9, HIGH);
  delay(300);
  digitalWrite(12, LOW);
  digitalWrite(9, LOW);
  delay(300);
  digitalWrite(12, HIGH);
  digitalWrite(9, HIGH);
  delay(300);
  digitalWrite(12, LOW);
  digitalWrite(9, LOW);
  delay(300);
  digitalWrite(12, HIGH);
  digitalWrite(9, HIGH);
  delay(300);
  digitalWrite(12, LOW);
  digitalWrite(9, LOW);
  delay(300);
```

```
  digitalWrite(0, LOW);
  digitalWrite(10, LOW);
  digitalWrite(A5, HIGH);

  delay(3000);

  digitalWrite(6, HIGH);
  digitalWrite(9, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(9, LOW);
  delay(300);
  digitalWrite(6, HIGH);
  digitalWrite(9, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(9, LOW);
  delay(300);
  digitalWrite(6, HIGH);
  digitalWrite(9, HIGH);
  delay(300);
  digitalWrite(6, LOW);
  digitalWrite(9, LOW);
  delay(300);

  digitalWrite(8, LOW);
  digitalWrite(A1, LOW);

  count=1;
  }
 }

}
```

## METHOD - B, CASE - E:

- Green and Blue signals at road 4 and 3 respectively are turned on.

- After a delay of 3 seconds, Yellow signals at road 4 and 3 are blinked to indicate that they are going to change signal next.

- Green and Blue signals at road 4 are turned on, Blue signal at road 3 is turned off.

- After a delay of 3 seconds, Yellow signals at road 4 and 1 are blinked to indicate that they are going to change signal next.

- Count is set to 1.