1st Lab work: Building an embedded system

Group	1
Student 1	89470 - João Coutinho
Student 2	89472 - João Porto

Design the interface:

Calculate the values of resistors associated with the LEDs:

$$max\_i = 40\,mA,\ i = 15\,mA$$

$$v = Power - VoltageDrop$$

$$R = \frac{v}{i}$$

R_red:

$VoltageDrop = 1.89\,V$

$v = 5 - 1.89 = 3.11\,V$

$R = \frac{3.11}{0.015} = 207.33\,\Omega$

R_green:

$VoltageDrop = 2.07\,V$

$v = 5 - 2.07 = 2.93\,V$

$R = \frac{2.93}{0.015} = 195.33\,\Omega$

R_blue:

$VoltageDrop = 2.94\,V$

$v = 5 - 2.94 = 2.06\,V$

$R = \frac{2.06}{0.015} = 137.33\ \Omega$

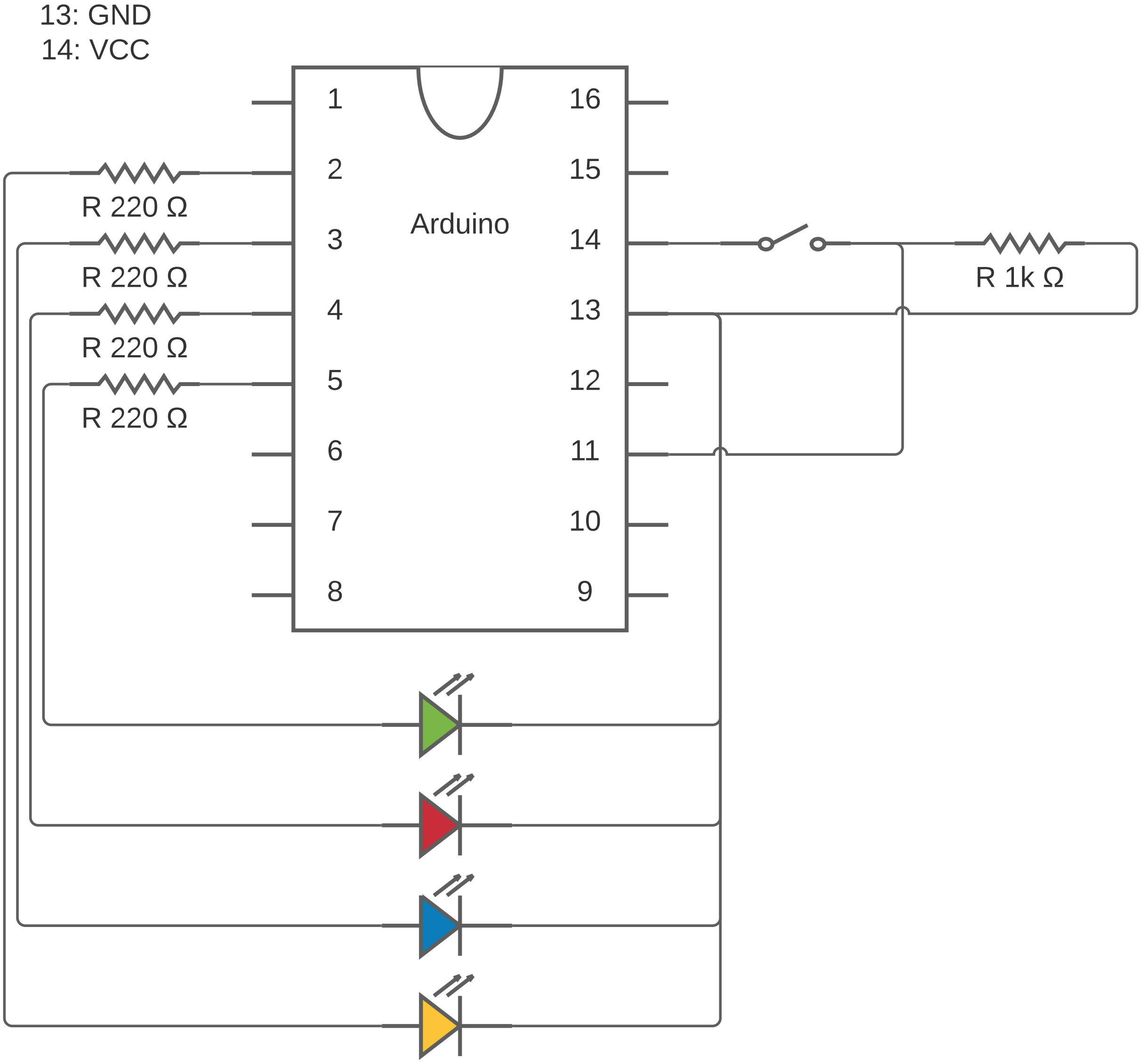
R_yellow:

$VoltageDrop = 2.01\ V$

$v = 5 - 2.01 = 2.99\ V$

$R = \frac{2.99}{0.015} = 199.33\ \Omega$

Draw and design the press button interface to the controller:



Measure the voltage drops on the LEDs:

V_red: 1.89 V

V_green: 2.07 V

V_blue: 2.94 V

V_yellow: 2.01 V

Estimate the power consumption of the interface (the circuit with the resistors and LEDs in the figure) in normal operation:

$$v = R \times i \Leftrightarrow i = \frac{v}{R}$$

$$p = v \times i = \frac{v^2}{R}$$

When red LED is lit:

$v = 3.11\ V,\ R = 220\ \Omega$

$p = \frac{3.11^2}{220} = 0.04396\ W = 43.96\ mW$

When green led is lit:

$v = 2.93\ v,\ R = 220\ \Omega$

$p = \frac{2.93^2}{220} = 0.03902\ W = 39.02\ mW$

When blue led is lit:

$v = 2.06\ v,\ R = 220\ \Omega$

$p = \frac{2.06^2}{220} = 0.01929\ W = 19.29\ mW$

When yellow led is lit:

$v = 2.99\ v,\ R = 220\ \Omega$

$p = \frac{2.99^2}{220} = 0.04064\ W = 40.64\ mW$

Max consumption: $43.96\ mW$, **Average consumption:** $\frac{43.96+39.02+19.29+40.64}{5} = \frac{142.91}{5} = 28.58\ mW$

Program the application:

Add your program listing (adequately structured and commented):

```
const int GREEN = 5;
const int RED = 4;
const int BLUE = 3;
const int YELLOW = 2;
const int BUTTON = 11;

void setup()
{
  pinMode(GREEN, OUTPUT);
  pinMode(RED, OUTPUT);
  pinMode(BLUE, OUTPUT);
  pinMode(YELLOW, OUTPUT);
  pinMode(BUTTON, INPUT);
  pinMode(LED_BUILTIN, OUTPUT); // use builtin LED as paused
indicator

  digitalWrite(GREEN, LOW);  // turn the LED off (LOW is the
voltage level)
  digitalWrite(RED, LOW);    // turn the LED off (LOW is the
voltage level)
  digitalWrite(BLUE, LOW);   // turn the LED off (LOW is the
voltage level)
  digitalWrite(YELLOW, LOW); // turn the LED off (LOW is the
voltage level)
}

void loop()
{
  // 1st
  blink(RED, 1000);

  // 2nd
  blink(GREEN, 1000);
  // 3rd
  blink(BLUE, 1000);

  // 4th
  blink(YELLOW, 1000);

  // 5th
  wait(1000); // wait 1000ms
}

// Function to blink the LED
void blink(int led, long duration)
{
  digitalWrite(led, HIGH); // turn the LED on (HIGH is the voltage
level)
  wait(duration);          // wait 1000ms
  digitalWrite(led, LOW);  // turn the LED off by making the
voltage low
}

// Our interpretation of the guide is that the system remains
paused between button presses
// and not while the button is pressed
void wait(unsigned long duration)
{
  unsigned long current_time = millis();
  bool paused = false;
  delay(10);

  while (millis() - current_time < duration)
  {

    // Toggle paused state when button is pressed
    if (digitalRead(BUTTON) == HIGH)
    {
      paused = !paused;
      duration -= millis() - current_time; // Deduct already
elapsed time from duration
```

```
      delay(250);                          // Buffer wait to allow
button to depress
    }

    // Freeze time when state is paused
    if (paused)
    {
      digitalWrite(LED_BUILTIN, HIGH);
      current_time = millis();
    }
    else
    {
      digitalWrite(LED_BUILTIN, LOW);
    }
  }
}
```