

Dhirubhai Ambani University

(Formerly known as DA-IICT)

Topic: Introduction to Embedded System

Course: Programming Lab
Course Code- PC503

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Embedded System

REVIEW AND RANK THE POINTS IN YOUR SYSTEM

What is an Embedded System?

An **embedded system** is a combination of **hardware** and **software** designed to perform a specific function within a larger system.

Main Components

1. Hardware

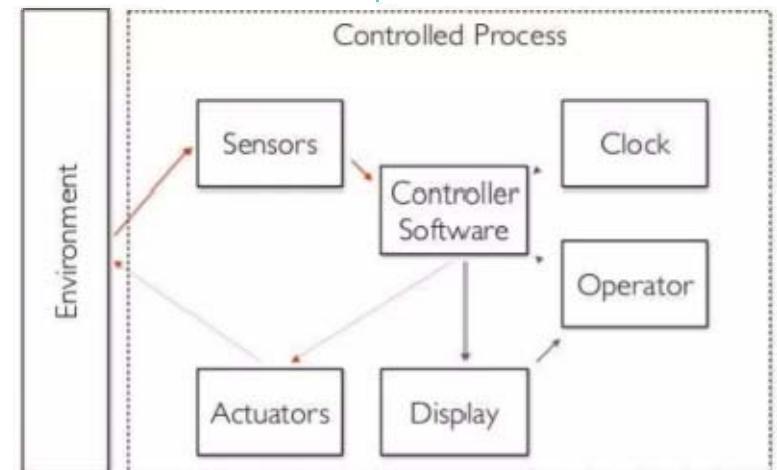
1. **Processor (Microcontroller or Microprocessor)**: The brain that runs the control program.
2. **Memory**: For program storage (ROM/Flash) and temporary data (RAM).
3. **Input/Output Devices**: Sensors (inputs) and actuators or displays (outputs).
4. **Power Supply**: To run the system.

2. Software (Firmware)

1. Written in C, C++, or assembly.
2. Stored in ROM/Flash.
3. Executes continuously, usually with real-time constraints.

How it works?

- Sensors collect data from the environment.
- The processor (controller) runs software to make decisions.
- Actuators carry out physical actions based on those decisions.
- The system continuously monitors and reacts to changes, often in **real-time**.



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Microprocessor (MPU)

- A microprocessor is the central processing unit (CPU) of a computer system, basically, the *brain* that performs calculations and runs programs.
- However, a microprocessor cannot work by itself. It needs external components like:
 - RAM (for temporary data)
 - ROM / Storage (for programs)
 - Input/Output (I/O) interfaces
 - Timers and communication ports
- So, a microprocessor-based system (like a PC) is made up of *many separate chips* working together.

Even though a microcontroller (like the ATmega328) already has CPU, memory, and I/O built in, sometimes we need **extra or specialized components** depending on the application.

Microcontroller (MCU)

- A microcontroller is a single integrated circuit (IC) that includes:
 - CPU (microprocessor core)
 - Memory (RAM + Flash/ROM)
 - Input/Output ports
 - Timers, ADCs, and peripherals
- It's a complete computer on a single chip, designed to control specific electronic systems.



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Arduino

- Arduino is an open-source electronics platform based on easy-to-use hardware and software.
- An Arduino board can read inputs and convert them into outputs.

Why Arduino?

- Inexpensive
- Cross-platform- Windows/Linux/Mac
- Simple, clear programming environment
- Open source and extensible software

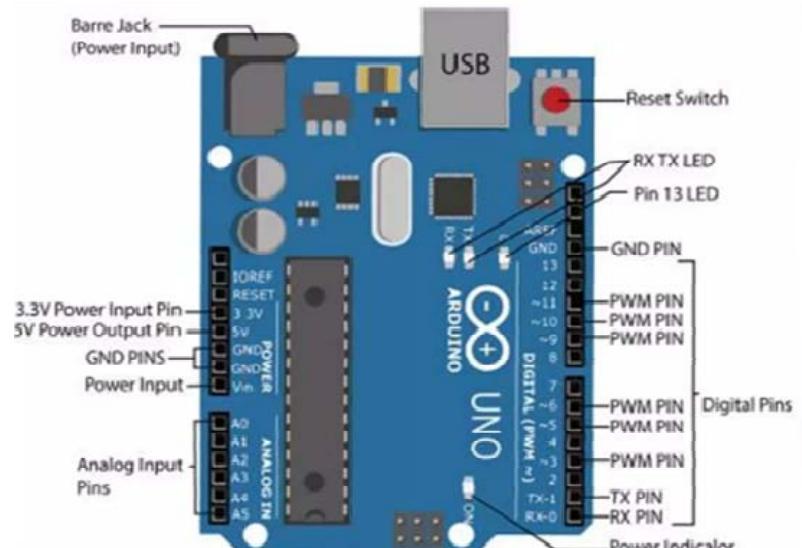


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Different types of Arduino board



Arduino Uno Pins

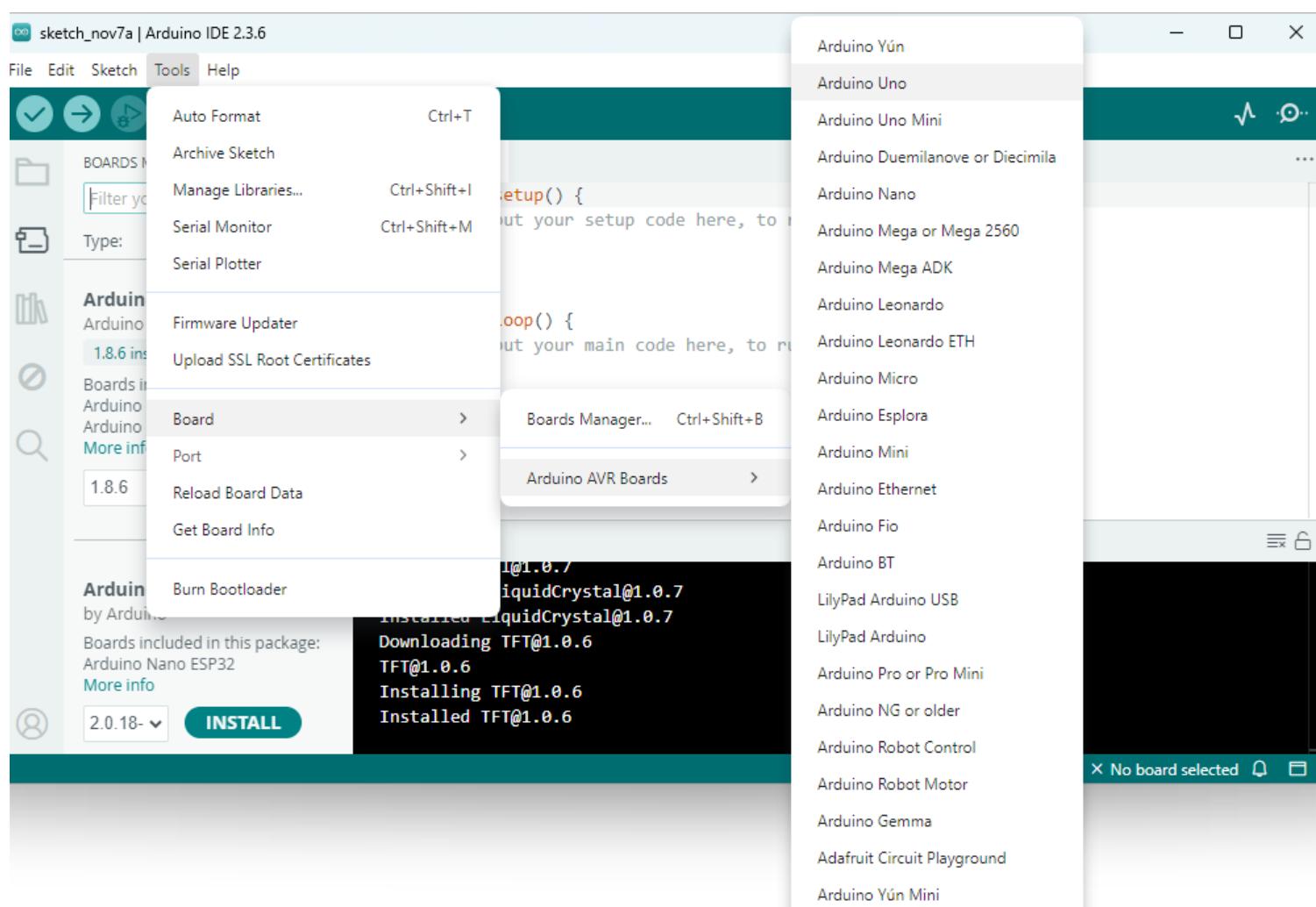


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Arduino IDE



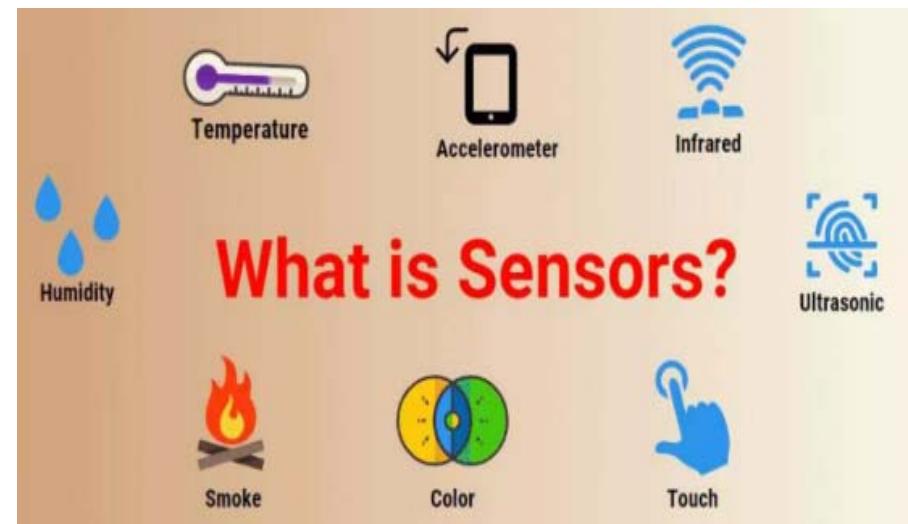
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Sensors:

- A **sensor** is a device that **detects changes** in the physical environment and **converts them into electrical signals** that a system (like a microcontroller) can understand.
- Any physical quantity like pressure, force, strain, etc.
- These are classified as
 - Analog Sensor
 - Digital Sensor



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REVIEW AND RANK THE PAPER IN YOUR COUNTRY

Actuators:

- An **actuator** is a device that **converts electrical signals** (from a microcontroller or control system) into **physical action**, such as movement, rotation, or force.
- Examples:
 - Motor
 - LED
 - LCD

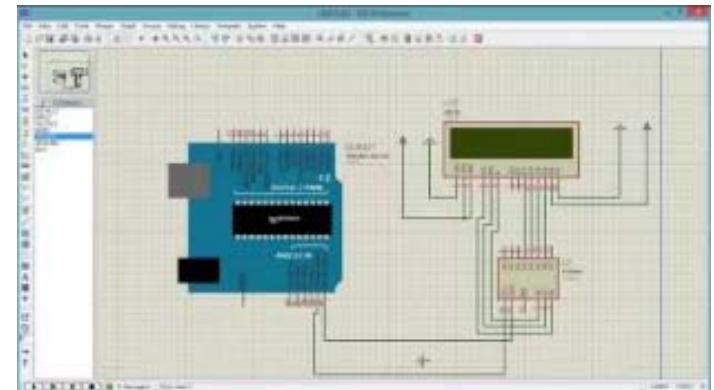


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Simulation Software's



Tinkercad



Proteus

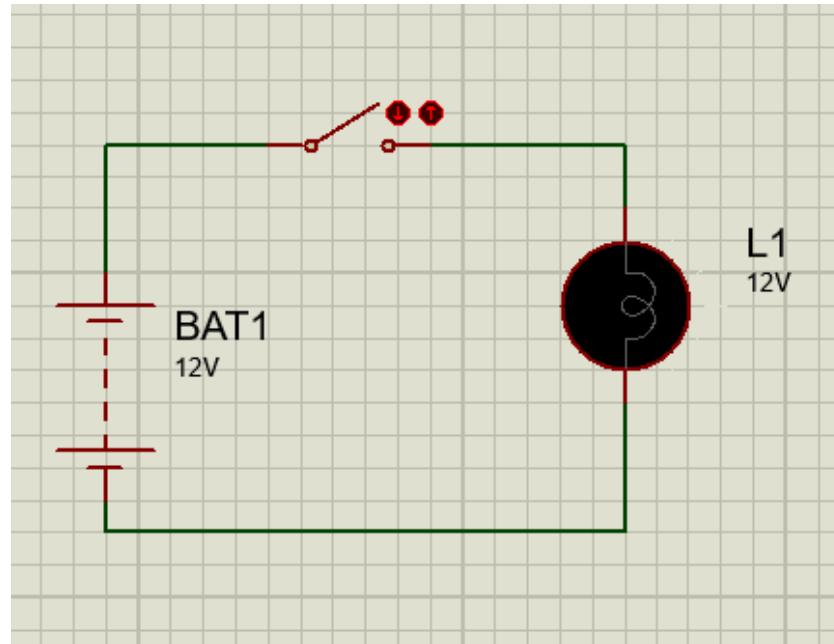


Fritzing

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RESULTS ARE VALID FOR THIS COURSE

Simple Circuit Simulation



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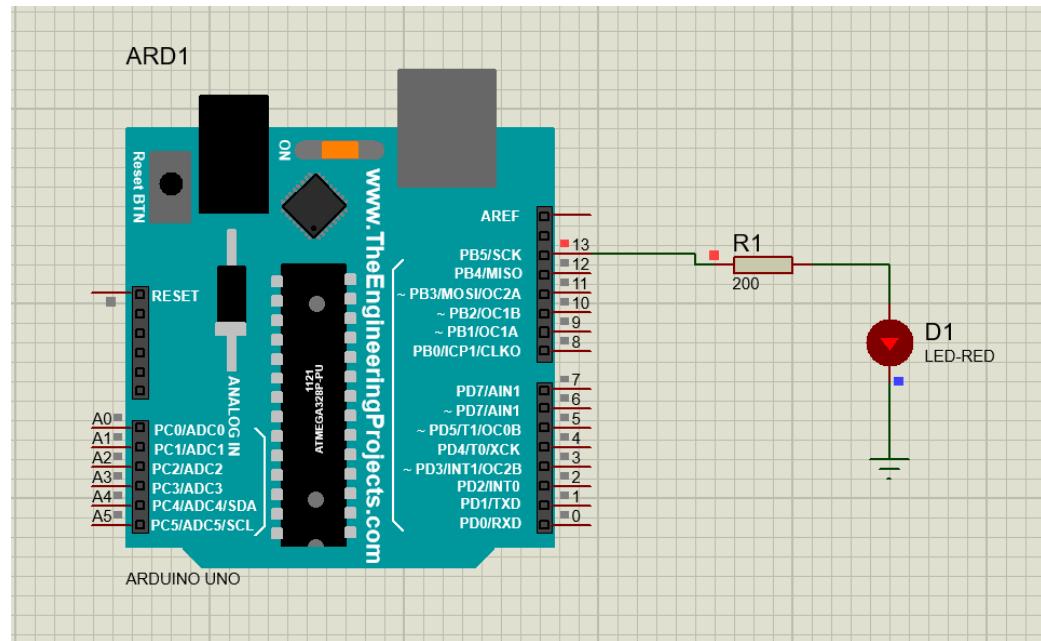
RESULTS ARE VALID FOR THIS COURSE

LED Blinking

```
int ledPin1 = 13;

void setup()
{
  pinMode(ledPin1, OUTPUT);
}

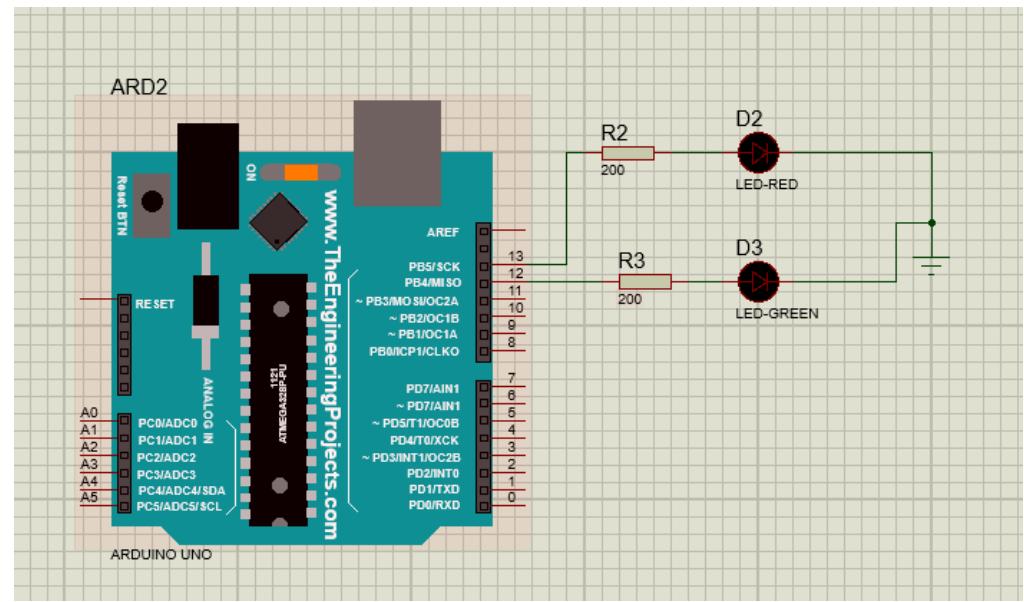
void loop() {
  digitalWrite(ledPin1, HIGH);
  delay(2000);
  digitalWrite(ledPin1, LOW);
  delay(2000);
}
```



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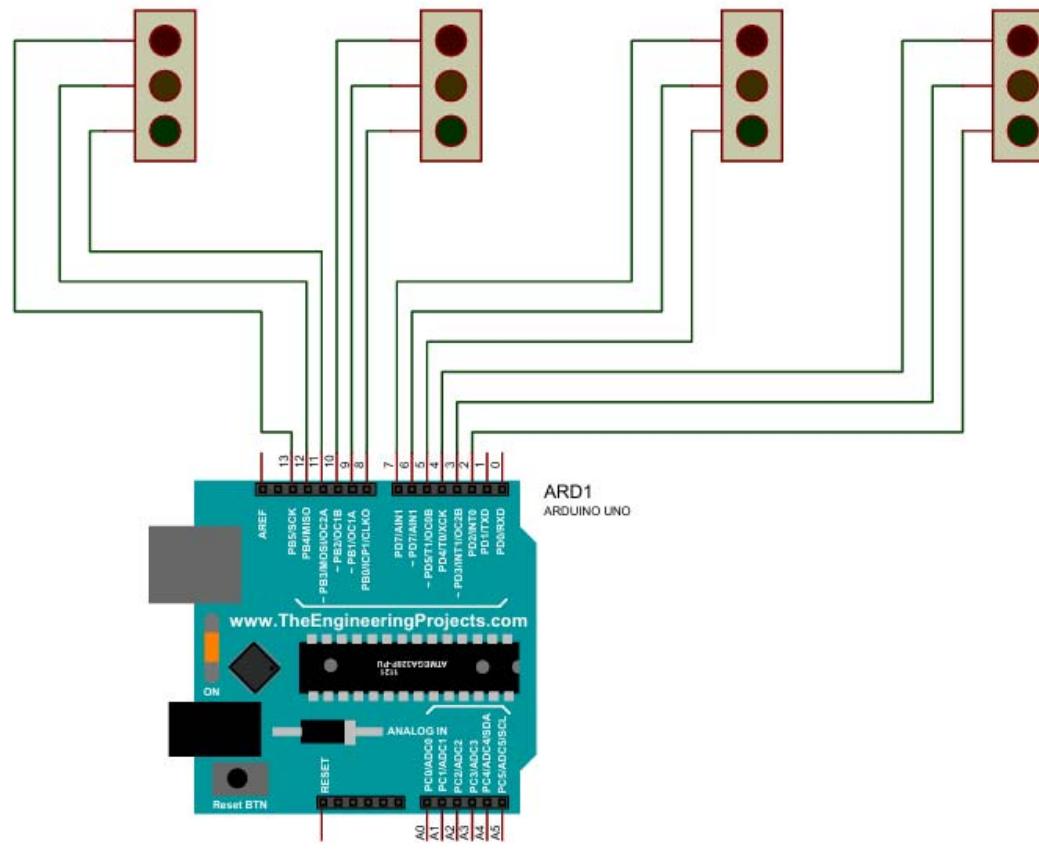
LED Blinking

```
int ledPin1 = 13;  
int ledPin2= 12;  
  
void setup()  
{  
    pinMode(ledPin1, OUTPUT);  
    pinMode(ledPin2, OUTPUT);  
}  
  
void loop() {  
    digitalWrite(ledPin1, HIGH);  
    digitalWrite(ledPin2, LOW);  
    delay(2000);  
    digitalWrite(ledPin1, LOW);  
    digitalWrite(ledPin2, HIGH);  
    delay(2000);  
}
```



Embedded System

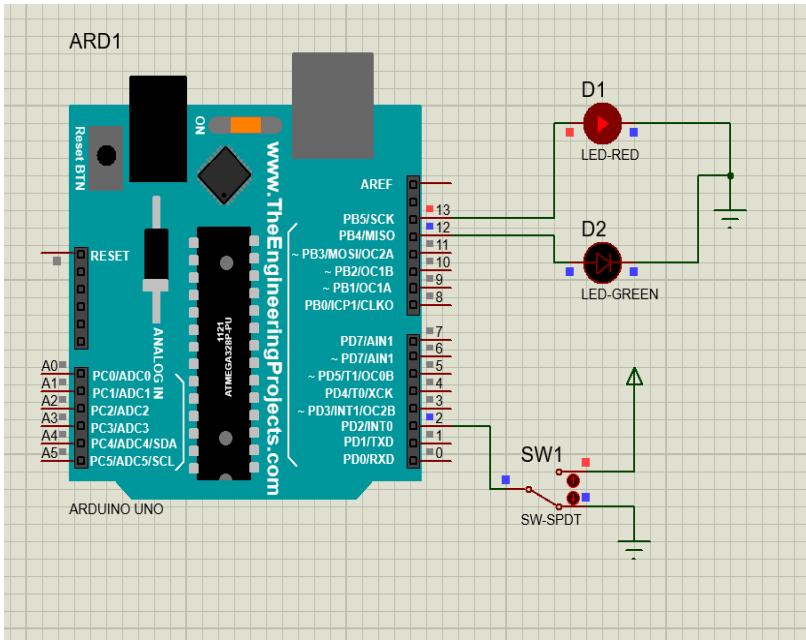
Traffic Light



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LED Blinking with Switch

```
int ledPin1 = 13;  
int ledPin2 = 12;  
int inputPin = 2;  
  
int reading;  
  
void setup() {  
    pinMode(ledPin1, OUTPUT);  
    pinMode(ledPin2, OUTPUT);  
    pinMode(inputPin, INPUT);  
}
```

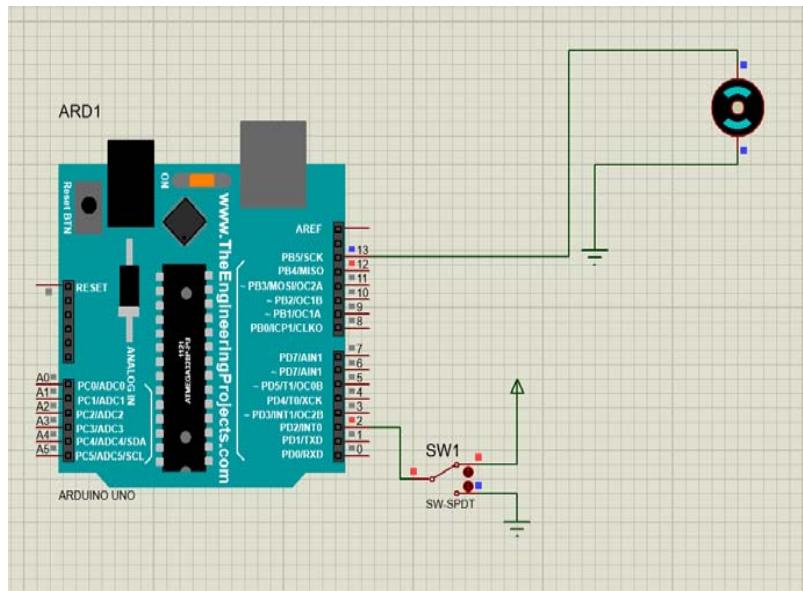


```
void loop() {  
    reading = digitalRead(inputPin);  
  
    if (reading == LOW)  
    {  
        digitalWrite(ledPin1, HIGH);  
        digitalWrite(ledPin2, LOW);  
    }  
    else  
    {  
        digitalWrite(ledPin1, LOW);  
        digitalWrite(ledPin2, HIGH);  
    }  
    delay(2000);  
}
```

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LED Blinking with Switch

```
int ledPin1 = 13;  
int ledPin2 = 12;  
int inputPin = 2;  
  
int reading;  
  
void setup() {  
    pinMode(ledPin1, OUTPUT);  
    pinMode(ledPin2, OUTPUT);  
    pinMode(inputPin, INPUT);  
}
```

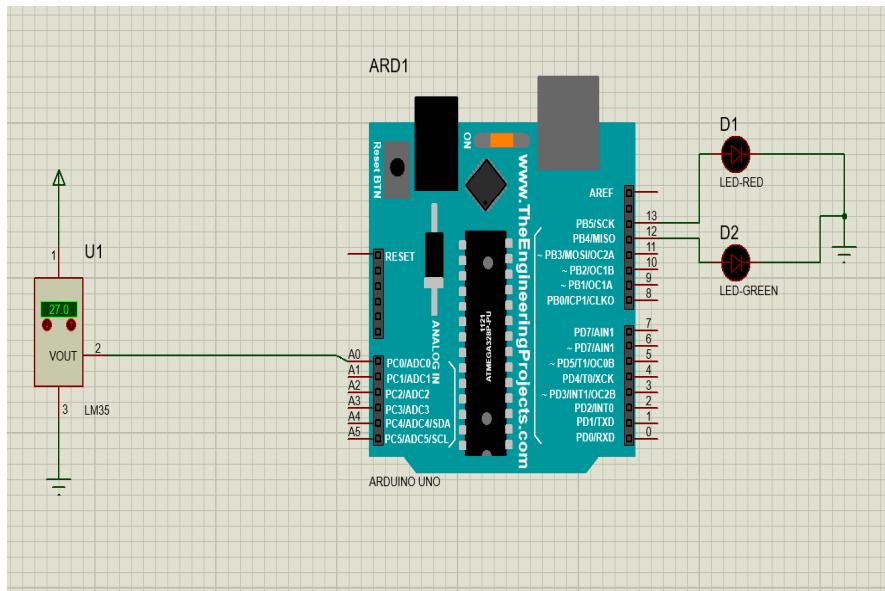


```
void loop() {  
    reading = digitalRead(inputPin);  
  
    if (reading == LOW)  
    {  
        digitalWrite(ledPin1, HIGH);  
        digitalWrite(ledPin2, LOW);  
    }  
    else  
    {  
        digitalWrite(ledPin1, LOW);  
        digitalWrite(ledPin2, HIGH);  
    }  
    delay(2000);  
}
```

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LED Blinking with Temperature Sensor (LM35)

```
int ledPin1 = 13;  
int ledPin2 = 12;  
int tempPin = A0;  
  
float tempC;  
int reading;  
  
void setup() {  
    pinMode(ledPin1, OUTPUT);  
    pinMode(ledPin2, OUTPUT);  
    pinMode(tempPin, INPUT);  
    analogReference(DEFAULT);  
}
```



```
void loop() {  
    reading = analogRead(tempPin);  
    tempC = (reading * 5.0 / 1023.0) * 100.0;  
    // For LM35  
  
    if (tempC > 60)  
    {  
        digitalWrite(ledPin1, HIGH);  
        digitalWrite(ledPin2, LOW);  
    }  
    else  
    {  
        digitalWrite(ledPin1, LOW);  
        digitalWrite(ledPin2, HIGH);  
    }  
  
    delay(2000);  
}
```