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## 1. What is Arduino?

- Arduino is an open-source electronics platform combining hardware and software.
  - Microcontroller Boards: Arduino UNO, Mega, Nano, etc.
  - Languages: C/C++ (with Arduino libraries).
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## 2. Setting Up Arduino IDE

- Download: <https://www.arduino.cc/en/software>
  - Install on Windows/Mac/Linux.
  - Connect Board: Use USB cable.
  - Select Board and Port:
    - Tools > Board > Arduino Uno
    - Tools > Port > COM (USB)
- 

## 3. Basic Structure of Arduino Code

```
// Runs once when the board starts
void setup() {
  pinMode(LED_BUILTIN, OUTPUT); // Initialize pin
}

// Loops continuously after setup
void loop() {
  digitalWrite(LED_BUILTIN, HIGH); // Turn LED on
  delay(1000); // Wait 1 second
  digitalWrite(LED_BUILTIN, LOW); // Turn LED off
  delay(1000); // Wait 1 second
}
```

Key Functions:

- setup() - Runs once when the board powers on.
  - loop() - Repeats continuously.
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## 4. Uploading Code

1. Write code in the Arduino IDE.
2. Click Upload (→) or press Ctrl + U.
3. The board will reset and run the code.

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## 5. Pin Modes

```
pinMode(pin, mode);
```

- INPUT - Receives data (sensors).
- OUTPUT - Sends data (LEDs, motors).
- INPUT\_PULLUP - Internal pull-up resistor (for switches).

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## 6. Digital I/O

```
digitalWrite(pin, HIGH); // Turn on  
digitalWrite(pin, LOW); // Turn off
```

```
int value = digitalRead(pin); // Read pin (HIGH/LOW)
```

- HIGH - 5V (On).
- LOW - 0V (Off).

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## 7. Analog I/O

### **Analog Read (0-1023):**

```
int sensorValue = analogRead(A0); // Read value from pin A0
```

### **Analog Write (PWM, 0-255):**

```
analogWrite(9, 128); // Write PWM signal to pin 9
```

---

## 8. Serial Communication

```
Serial.begin(9600);           // Start Serial at 9600 baud
Serial.println("Hello!");     // Print with newline
Serial.print("Value: ");      // Print without newline
Serial.print(sensorValue);
```

---

## 9. Control Structures

### If-Else Statement:

```
if (sensorValue > 500) {
  digitalWrite(LED_BUILTIN, HIGH);
} else {
  digitalWrite(LED_BUILTIN, LOW);
}
```

### For Loop:

```
for (int i = 0; i < 10; i++) {
  Serial.println(i);
}
```

### While Loop:

```
while (digitalRead(2) == LOW) {
  Serial.println("Waiting...");
}
```

---

## □ 10. Common Functions

Function	Description
pinMode()	Sets pin mode (INPUT/OUTPUT)
digitalWrite()	Writes HIGH/LOW to a digital pin

<b>Function</b>	<b>Description</b>
digitalRead()	Reads value from a digital pin
analogRead()	Reads value (0-1023) from analog pin
analogWrite()	Outputs PWM signal (0-255)
delay(ms)	Pauses for milliseconds
millis()	Returns time since start (ms)

---

## 11. Sensors and Modules

### LED Blinking (Basic Example):

```
pinMode(LED_BUILTIN, OUTPUT);

void loop() {
  digitalWrite(LED_BUILTIN, HIGH);
  delay(500);
  digitalWrite(LED_BUILTIN, LOW);
  delay(500);
}
```

### Button Input:

```
pinMode(2, INPUT);

void loop() {
  if (digitalRead(2) == HIGH) {
    Serial.println("Button Pressed");
  }
}
```

### Temperature Sensor (LM35):

```
int temp = analogRead(A0);
float temperature = (temp / 1023.0) * 500;
Serial.println(temperature);
```

---

## 12. Controlling Motors

### Servo Motor (Using Servo Library):

```
#include <Servo.h>

Servo servoMotor;
servoMotor.attach(9); // Attach to pin 9

void loop() {
  servoMotor.write(90); // Move to 90 degrees
  delay(1000);
  servoMotor.write(0); // Move to 0 degrees
  delay(1000);
}
```

---

## 13. Ultrasonic Sensor (Distance Measurement)

```
const int trigPin = 9;
const int echoPin = 10;

void setup() {
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  Serial.begin(9600);
}

void loop() {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
```

```
long duration = pulseIn(echoPin, HIGH);
int distance = duration * 0.034 / 2;
Serial.print("Distance: ");
Serial.print(distance);
Serial.println(" cm");
delay(500);
}
```

---

## 14. Troubleshooting Tips

- Check Wiring - Ensure correct connections to pins.
  - Verify Board/Port - Recheck board and port selection.
  - Test with Basic Sketch - Upload a simple LED blink to verify hardware.
  - Restart Arduino IDE - Sometimes restarting the IDE resolves upload issues.
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## 15. Useful Arduino Libraries

```
#include <Servo.h>           // Servo motor control
#include <Wire.h>            // I2C communication
#include <Adafruit_Sensor.h> // Adafruit sensor library
```

- Install libraries via Sketch > Include Library > Manage Libraries.
- 

### Example: Full Project (Temperature and LED Control)

```
const int tempPin = A0;
const int ledPin = 9;

void setup() {
  pinMode(ledPin, OUTPUT);
  Serial.begin(9600);
}
```

```
void loop() {
  int temp = analogRead(tempPin);
  float temperature = (temp / 1023.0) * 500;
  Serial.print("Temp: ");
  Serial.println(temperature);

  if (temperature > 30) {
    digitalWrite(ledPin, HIGH);
  } else {
    digitalWrite(ledPin, LOW);
  }
  delay(1000);
}
```