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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)

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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
```

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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...");
}
```

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10. Common Functions

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

Function	Description
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)

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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);
```

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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);
}
```