**CODES**

**✅ Concept**

**UART (Universal Asynchronous Receiver/Transmitter) is a serial communication protocol that transmits data one bit at a time over a single channel. It uses:**

* **TX (Transmit)**
* **RX (Receive)**
* **GND (Ground)**
* **Baud rate must be the same on both devices (e.g., 9600).**

**✅ Components Required**

* **2 × Arduino Uno (or compatible boards)**
* **Jumper wires**
* **Breadboard (optional)**
* **USB cable for programming both boards**

**✅ Connections**

1. **Arduino 1 TX (Pin 1) → Arduino 2 RX (Pin 0)**
2. **Arduino 1 RX (Pin 0) → Arduino 2 TX (Pin 1)**
3. **GND → GND**

**Important:  
Disconnect the RX/TX wires when uploading code to avoid conflict with USB serial.**

**✅ Basic UART Example**

**Sender (Arduino 1):**

**void setup() {**

**Serial.begin(9600); // Initialize UART**

**}**

**void loop() {**

**Serial.println("Hello from Arduino 1");**

**delay(1000); // Send every 1 second**

**}**

**Receiver (Arduino 2):**

**void setup() {**

**Serial.begin(9600); // Same baud rate**

**}**

**void loop() {**

**if (Serial.available()) {**

**String msg = Serial.readStringUntil('\n');**

**Serial.println("Received: " + msg);**

**}**

**}**

**✅ Test**

* **Open Serial Monitor for Arduino 2 (Receiver).**
* **You should see “Received: Hello from Arduino 1” printed every second.**

**1. What is UART?**

**UART (Universal Asynchronous Receiver/Transmitter)** is a hardware communication protocol used for **serial data transfer** between two devices **without a shared clock**.

* Communication is **asynchronous** (no clock line, just data lines + ground).
* Uses **two main wires**:
  + **TX** (Transmit) → sends data
  + **RX** (Receive) → receives data
* Plus **common ground (GND)**.

**2. Why is it important?**

* It’s the simplest form of serial communication.
* Used in embedded systems, FPGA, microcontrollers for **debugging, sensors, modules** (GPS, Bluetooth, GSM, etc.).

**3. How UART works (Framing)?**

Data is sent **bit by bit** in a **frame format**:

* **Idle line**: HIGH (logic 1)
* **Start bit**: LOW (logic 0)
* **Data bits**: typically 8 bits, sent **LSB first**
* **Optional parity bit**
* **Stop bit(s)**: HIGH (logic 1), 1 or 2 bits

**Example:**  
For 8-N-1 format (8 data bits, No parity, 1 stop):

FRAME FORMAT :-

[Idle 1][Start 0][d0 d1 d2 d3 d4 d5 d6 d7][Stop 1]

**4. Baud Rate**

* Defines **speed** in bits per second (bps).
* Common values: **9600, 19200, 57600, 115200**.
* Both devices must use **same baud rate**, otherwise garbled data.

**5. Debugging UART**

If you get garbage:

* Check **baud rates match**.
* Verify **TX/RX crossed**.
* Ensure **common ground**.
* Try **loopback test** (short TX to RX on one device and see if it echoes).
* Avoid noise (keep wires short).