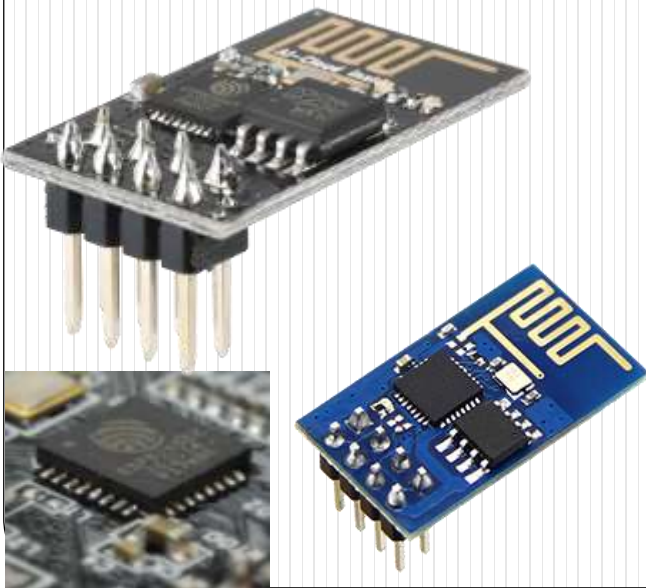




IoT

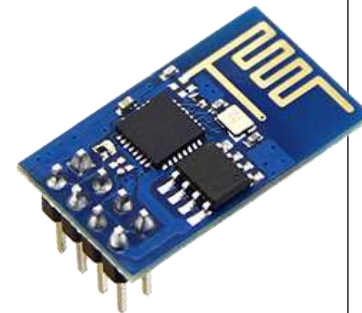
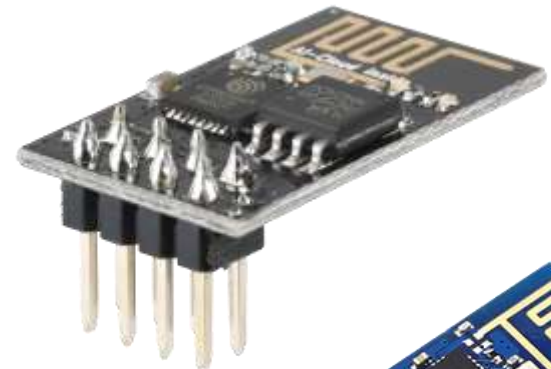
ESP 8266

Dr. Sarwan Singh
Deputy Director(S)
NIELIT Chandigarh



Agenda

- Types, Usage
- Interfacing with Arduino
- AT Commands
- Connecting to wifi network, posting data
- Uploading code in ESP8266
- ESP8266 as Web Server



ESP 8266

- System on Chip (SoC)
- Low cost
- Full TCP/IP stack (!!!!)
- Can be flashed with different firmwares
- Can also be programmed with Arduino IDE
- Many models

ESP8266 Types

- NodeMCU



ESP01



ESP02



ESP03



ESP04



ESP05



ESP06



ESP07



ESP08



ESP09



ESP10



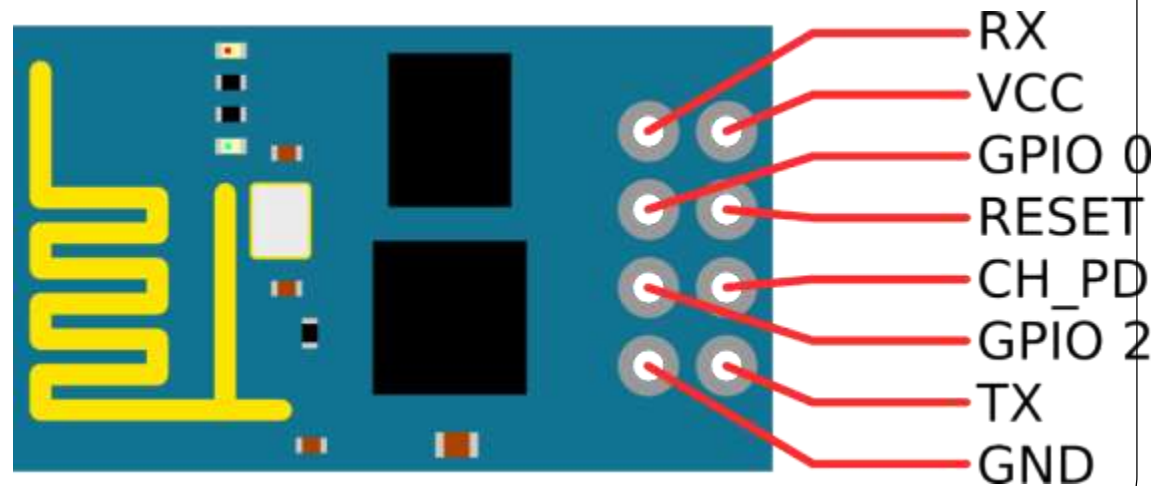
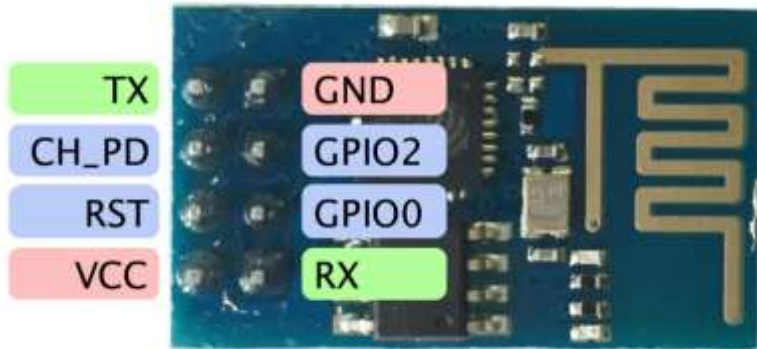
ESP11



ESP12



ESP 8266 Pinout



ESP8266-01

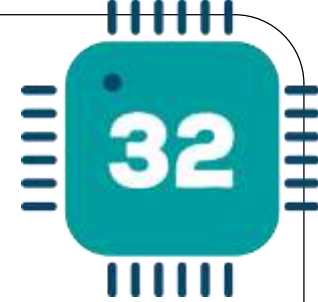
- 802.11 b/g/n
- Input power: 3.3V
- I/O voltage tolerance: 3.6V Max
- Regular operation current draw: $\sim 70\text{mA}$
- Peak operating current draw: $\sim 300\text{mA}$

Highly Integrated



- ESP8266EX is among the most integrated WiFi chips in the industry with the size of 5mm x 5mm
 - it integrates the antenna switches,
 - RF balun, power amplifier,
 - low noise receive amplifier, filters,
 - power management modules while requires minimal external circuitry.

<http://espressif.com/products/hardware/esp8266ex/overview/>



32-bit MCU

- ESP8266EX integrates Tensilica L106 32-bit micro controller (MCU) which features extra low power consumption and 16-bit RSIC.
- The CPU clock speed is 80 MHz.
- It can also reach a maximum value of 160 MHz.
- Real Time Operation System (RTOS) is enabled.
- Currently, only 20% of MIPS has been occupied by the Wi-Fi stack, the rest can all be used for user application programming and development.

Low Power



- ESP8266EX has been designed for mobile, wearable electronics and Internet of Things applications with the aim of achieving the lowest power consumption with a combination of several proprietary technologies.
- The power saving architecture operates in 3 modes:
 - active mode,
 - sleep mode and
 - deep sleep mode.

Robustness



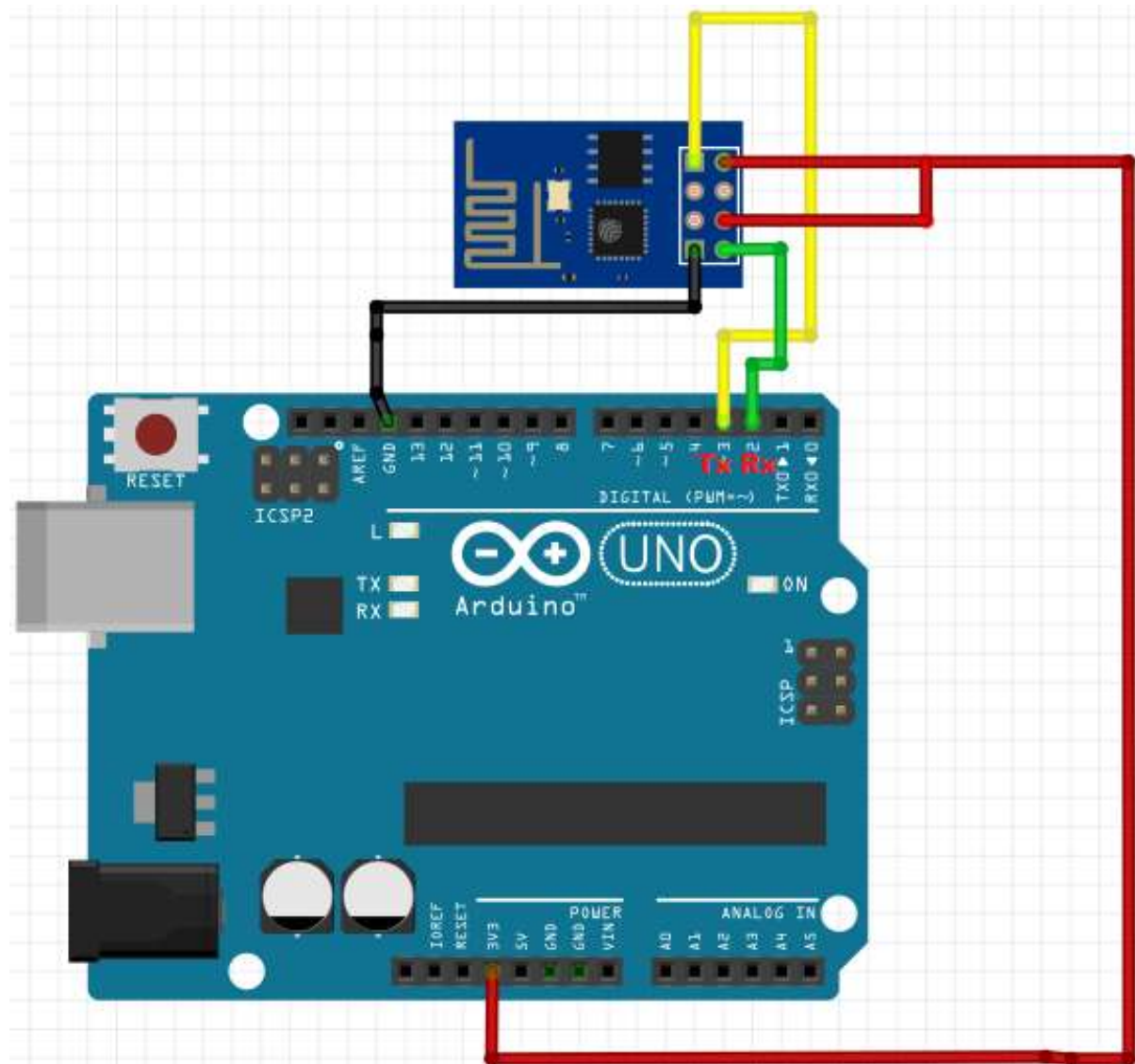
- By integrating more components on-chip, we have made the solution to be the most robust and manufacturable.
- Our solutions also feature the widest operating temperature range, from -40°C to $+125^{\circ}\text{C}$.

Coding

Interfacing ESP8266 with Arduino

Arduino interfacing with ESP8266

- V_{CC}
- Gnd
- R_x
- T_x



Arduino interfacing with ESP8266

Connections

Arduino | ESP8266

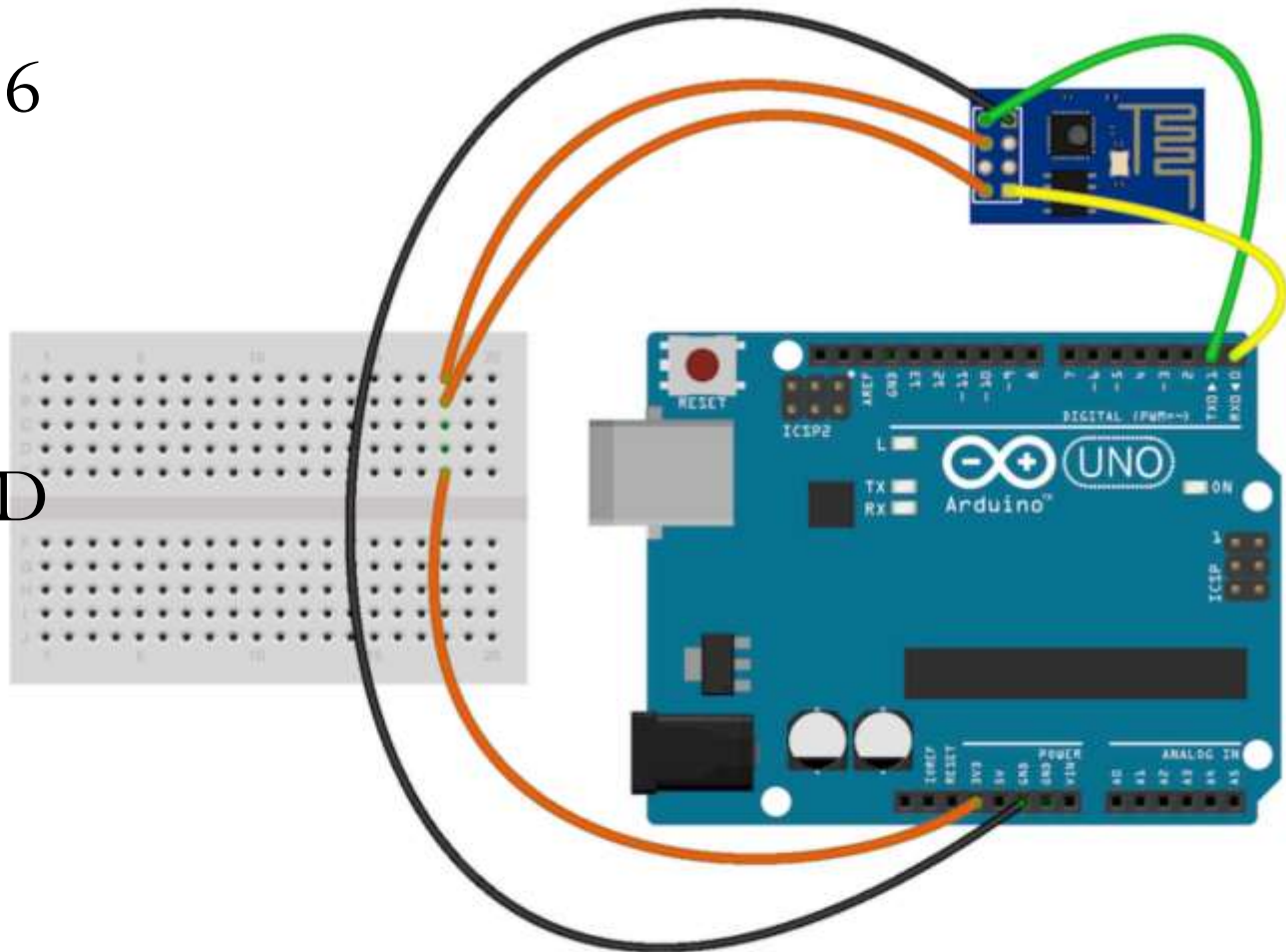
TX | RX

RX | TX

3.3V | VCC

3.3V | CH_PD

GND | GND



Software Serial

- The Arduino Uno has built-in support for serial communication on pins 0 and 1 (which also goes to the computer via the USB connection).
- The native serial support happens via a piece of hardware (built into the chip) called a UART.
- This hardware allows the Atmega chip to receive serial communication even while working on other tasks, as long as there room in the 64 byte serial buffer.
- The **SoftwareSerial** library has been developed to allow serial communication on other digital pins of the Arduino, using software to replicate the functionality (hence the name "SoftwareSerial").

SoftwareSerial

- It is possible to have multiple software serial ports with speeds up to 115200 bps.

Limitations

- If using multiple software serial ports, only one can receive data at a time.
- Not all pins on the Mega and Mega 2560 support SoftwareSerial

ESP8266 - AT Command

- ESP8266, in its default configuration, boots up into the serial modem mode.
- In serial mode communication is possible using a set of **AT commands**.

AT Commands

Basic	WiFi layer	TCPIP Layer
<u>AT</u>	<u>AT+CWMODE</u>	<u>AT+CIPSTATUS</u>
<u>AT+RST</u>	<u>AT+CWJAP</u>	<u>AT+CIPSTART</u>
<u>AT+GMR</u>	<u>AT+CWLAP</u>	<u>AT+CIPSEND</u>
<u>AT+GSLP</u>	<u>AT+CWQAP</u>	<u>AT+CIPCLOSE</u>
<u>ATE</u>	<u>AT+CWSAP</u>	<u>AT+CIFSR</u>
	<u>AT+CWLIF</u>	<u>AT+CIPMUX</u>
	<u>AT+CWDHCP</u>	<u>AT+CIPSERVER</u>
	<u>AT+CIPSTAMAC</u>	<u>AT+CIPMODE</u>
	<u>AT+CIPAPMAC</u>	<u>AT+CIPSTO</u>
	<u>AT+CIPSTA</u>	<u>AT+CIUPDATE</u>
	<u>AT+CIPAP</u>	<u>+IPD</u>



Arduino Code

```
void setup()
```

```
{  Serial.begin(115200);           // Begin serial monitor to receive 115200
                                     // bits per second (BAUD RATE)

  WiFi_Serial.println("AT+UART_DEF=9600,8,1,0,0");
  // set WiFi Send/Receive at 115200 bits per second
  // (BAUD RATE) to 9600 bits per second
  WiFi_Serial.begin(9600);
  // Begin SoftwareSerial with ESP at 9600 bps (BAUD RATE)
  WiFi_Serial.println("ATE0"); // turn echo off
  WiFi_Serial.println("AT+CWQAP");
  // Disconnect from previous network connections

}
```

<https://github.com/sarwansingh/Arduino/tree/master/ESPTestPostData>



```
void WIFI_Check()
```

```
{  
  WiFi_Serial.println("AT"); // send a Attention command  
  if (WiFi_Serial.available())  
  {  
    if (WiFi_Serial.find("OK")) // check with expected output  
    {  
      Serial.println("WIFI PLUGGED ONTO THE BOARD..!");  
      WiFi_Serial.println("AT+CWMODE=1");  
                                     //set mode to client mode  
      isESPonBoard = true;  
    }  
  } else {  
    Serial.println("WIFI NOT PLUGGED..! "); Serial.println();  
    Serial.println("PLUG IN YOUR WIFI CHIP"); Serial.println();  
  }  
}
```

AT+CWMODE - WIFI mode (station, AP, station + AP)

Variant	Command	Response	Function
Test	AT+CWMODE=?	+CWMODE:(1-3) OK	List valid modes
Query	AT+CWMODE?	+CWMODE:modeOK	Query AP's info which is connect by ESP8266.
Execute	AT+CWMODE=mode	OK	Set AP's info which will be connect by ESP8266.

mode : An integer designating the mode of operation either 1, 2, or 3.

1 = Station mode (client)

2 = AP mode (host)

3 = AP + Station mode (Yes, ESP8266 has a dual mode!)

void connectWiFi()

```
{
  WiFi_Serial.println("AT+CWJAP?");
  //check if WIFI connected to any WiFi network
  if (WiFi_Serial.available())
  {
    if (WiFi_Serial.find("No AP"))
      //we receive response "No AP" when not connected to any network
      {
        Serial.println("NOT CONNECTED TO WIFI NETWORK");
        Serial.println("Trying to Connect to WiFi Network");
      }
    String cmd = "AT+CWJAP=\""; // connected to specified
    //network passing mentioned WiFi username and password
    cmd += SSID; cmd += "\",\""; cmd += PASS; cmd += "\"";
    WiFi_Serial.println (cmd);
  }
}
```

void connectWiFi() Contd...

```

Serial.println("-->" + cmd);
if (WiFi_Serial.available())
{
    String RES_input = "";
    while (WiFi_Serial.available()) // read data into a variable
    {
        RES_input += (char)WiFi_Serial.read();
    }
    Serial.println(RES_input);
    if (WiFi_Serial.find("WIFI CONNECTED"))
    {
        Serial.println("CONNECTED TO WIFI NETWORK");
        isESPconnectedtoAP = true;
    }
}
}

```

void loop()

```
{  
  Serial.println("Welcome to ESP8266 interfacing");  
  while (1)  
  {  
    WIFI_Check();  
    if (isESPonBoard == true) {  
      connectWiFi(); postData();  
    }  
    delay(4000);  
  }  
}
```

void post()

```
{ //form the JSON string with the available sensor data
    String data;
    data += "{ \"username\": \"" + String(username) ;
    data += "\", \"name\": \"";
    data += String(Device_No);
    data += "\", \"sample1\": \"";
    data += String( CELSIUS); //(unsigned char)
    data += "\", \"sample2\": \"";
    data += String(HUM);
    data += "\", \"sample5\": \"";
    data += String(CO2);
    data += "\"}\"";
```


void post()

// form the header to post the WiFi data

String uri = "/iot/cht/rec.php";

String port = "80";

String http_req = "POST " + uri +
 " HTTP/1.1\r\n Host: " + DST_IP + ":" +
 port + "\r\n Accept: */*\r\n" +
 "Content-Length: "+data.length() + "\r\n" ;

String http_req1 =
 "Content-Type: application/json\r\n\r\n" ;

void post()

// starts a TCP connection

```
String cmd = "AT+CIPSTART=\"TCP\", \"";
```

```
cmd += DST_IP;    cmd += "\",80";
```

```
WiFi_Serial.println(cmd);
```

```
WiFi_Serial.print("AT+CIPSEND=");
```

```
WiFi_Serial.println(Total_req_data_Length);
```

```
if (WiFi_Serial.find(">"));    // when ">" is response from
```

WiFi that means it is ready to receive the total length of data

```
{
```

```
WiFi_Serial.print(http_req); // Send headder first
```

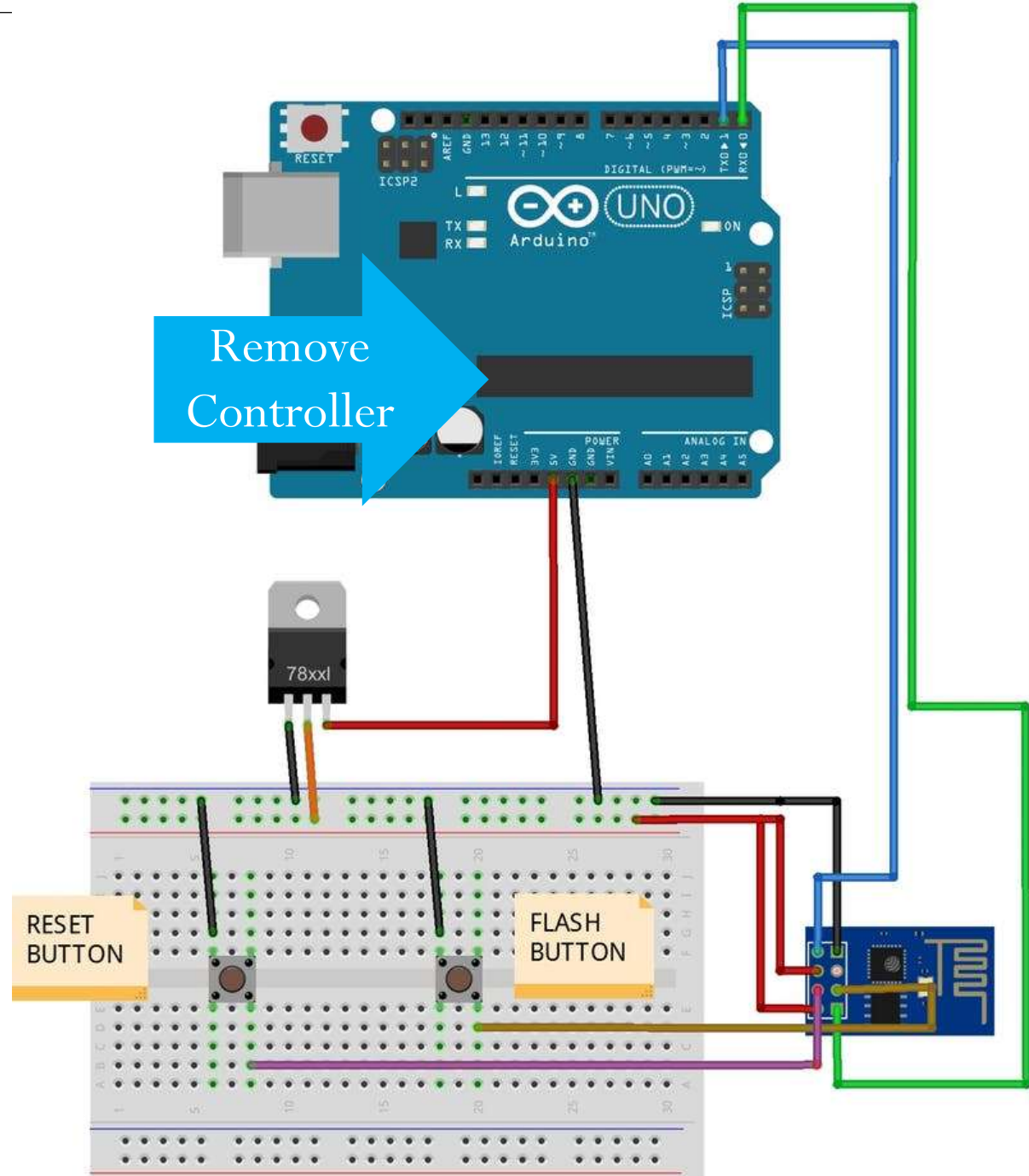
```
WiFi_Serial.print(http_req1);
```

```
WiFi_Serial.print(data); //later send data
```

```
}
```

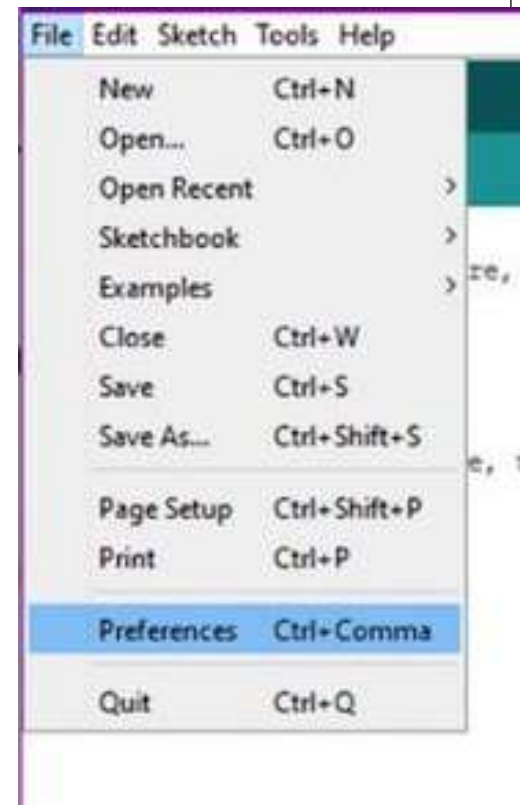
Uploading Code in ESP8266

Arduino	ESP8266 ESP-01
GND	GND
TX	TX
RX	RX
3.3V	VCC (3.3v req)

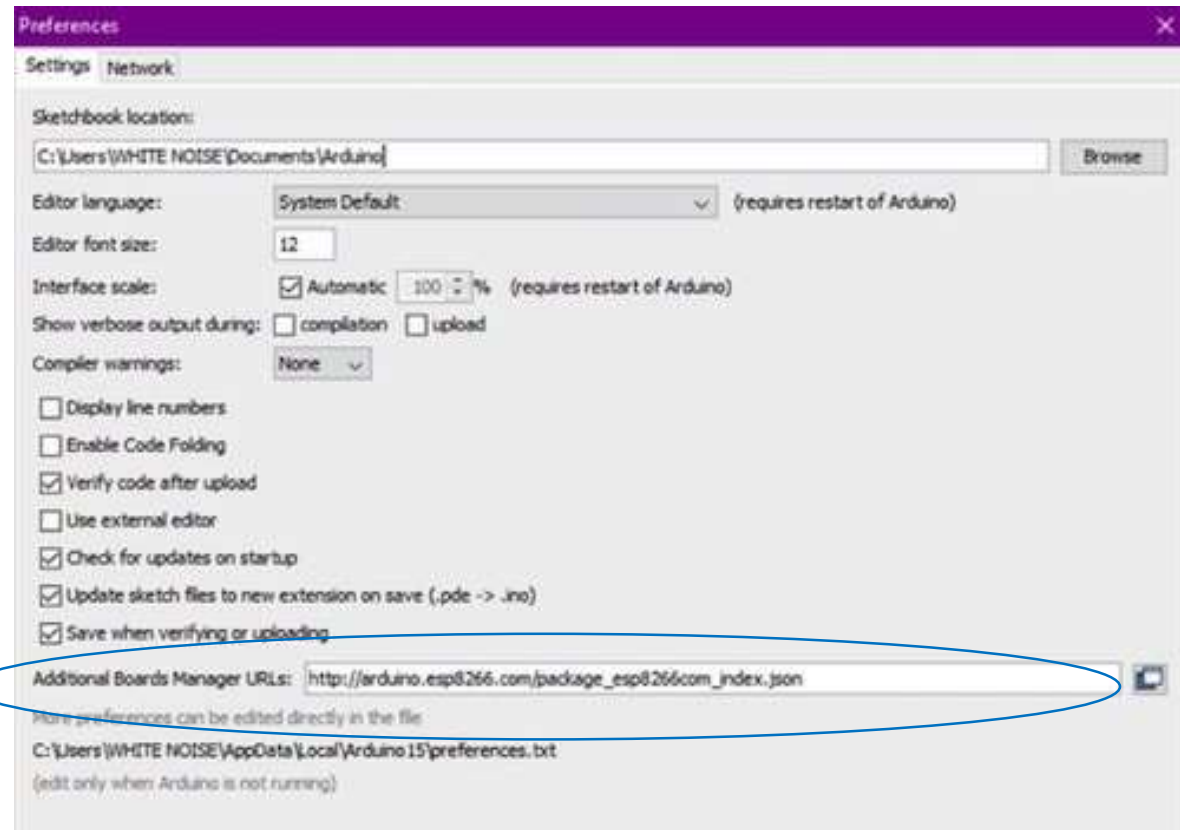


Installing the ESP8266 Platform

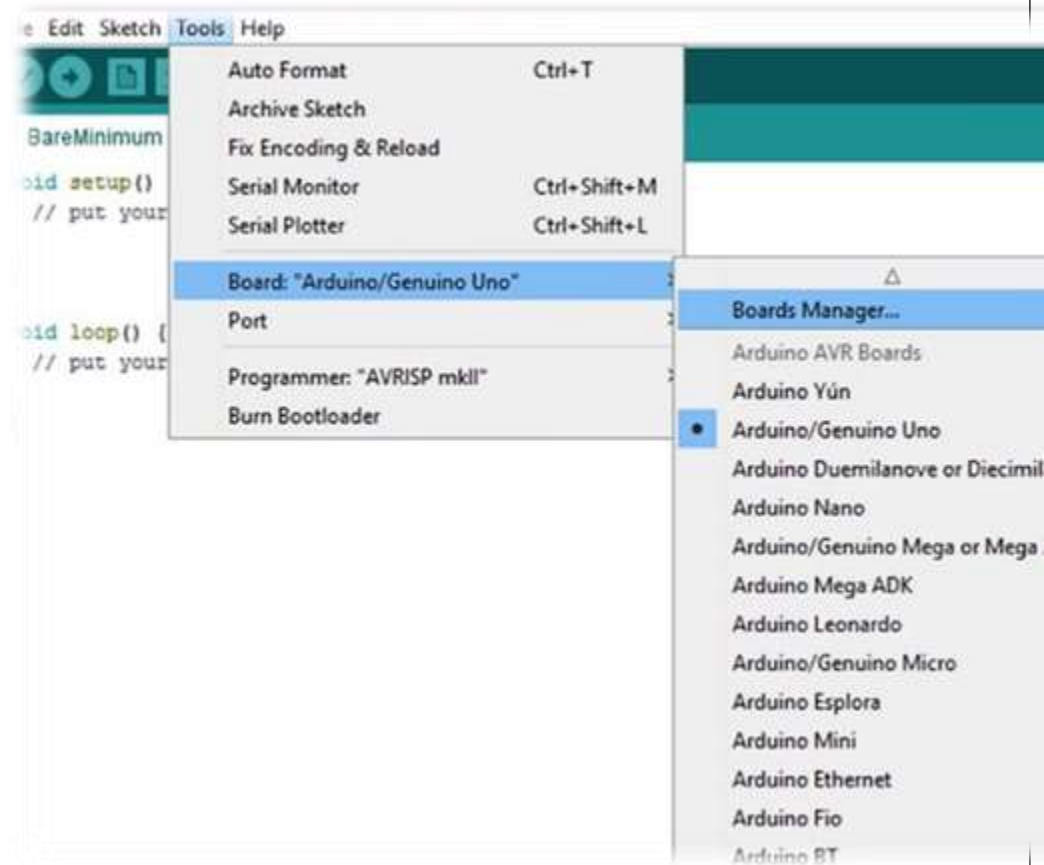
- First, the Arduino environment has to be set up to make it compatible with the **ESP-01** module.
- requirement : **Arduino version 1.6.4 or higher**
- Open the preferences window from the Arduino IDE. Go to File > Preferences



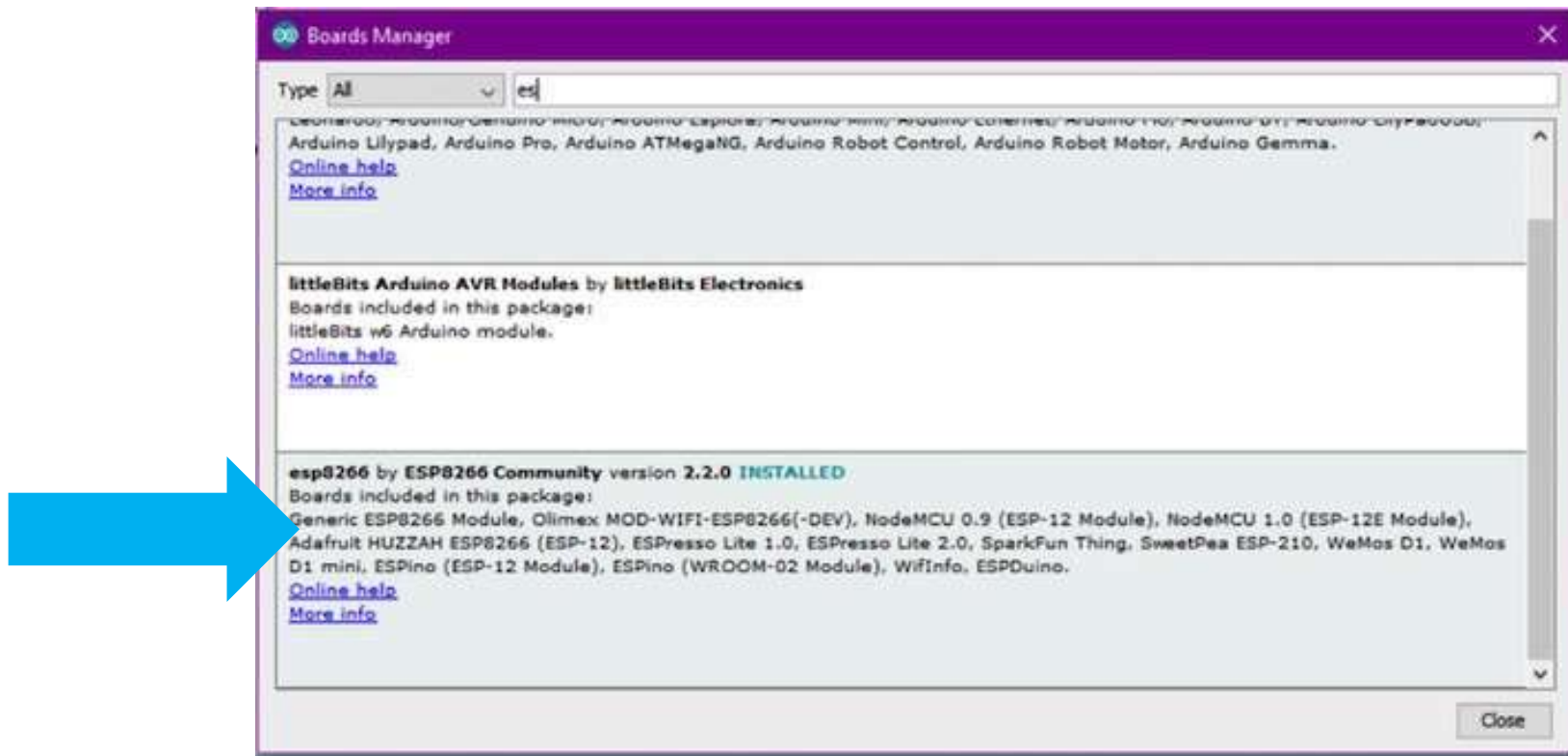
- Enter **`http://arduino.esp8266.com/stable/package_esp8266com_index.json`** into Additional Board Manager URLs field and click the “OK” button



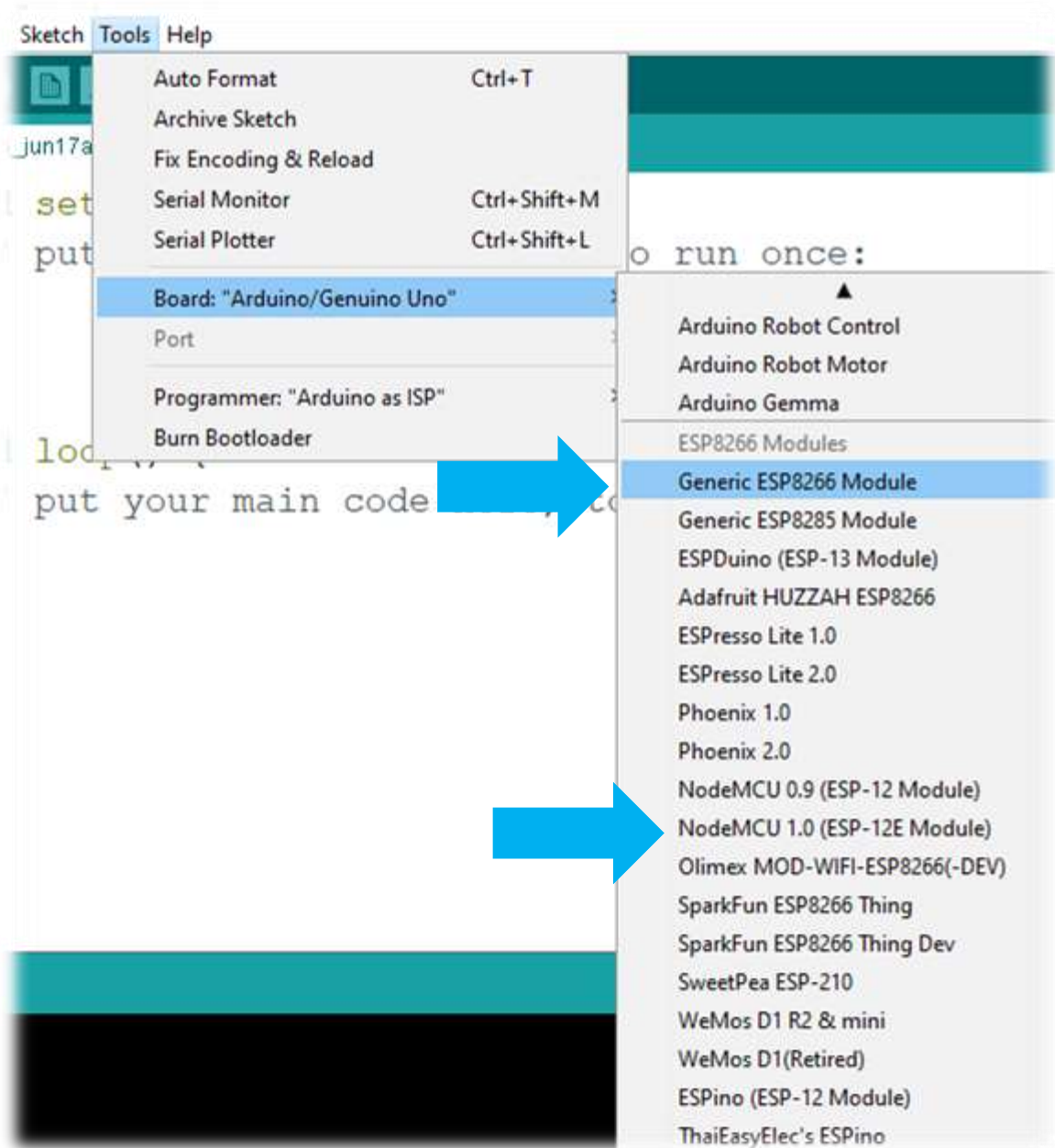
- Open boards manager. Go to:
Tools > Board > Boards Manager...



- Scroll down, select the ESP8266 board menu and install “esp8266 platform”.



- Choose your ESP8266 board from Tools > Board > Generic ESP8266 Module



```
#include <ESP8266WiFi.h>
```

```
const char* ssid = "YOUR_SSID";//type your ssid
```

```
const char* password = "YOUR_PASSWORD";//type your  
password
```

```
int ledPin = 2; // GPIO2 of ESP8266
```

```
WiFiServer server(80);
```

https://github.com/sarwansingh/Arduino/tree/master/ESP8266_Webserver

```
void setup() {
  Serial.begin(115200);
  delay(10);
  pinMode(ledPin, OUTPUT);
  digitalWrite(ledPin, LOW);
  // Connect to WiFi network
  Serial.println(); Serial.println();
  Serial.print("Connecting to ");
  Serial.println(ssid);
  WiFi.begin(ssid, password);
  while (WiFi.status() !=
    WL_CONNECTED) {
    delay(500); Serial.print(".");
  }
}
```

```
Serial.println("");
Serial.println("WiFi connected");

// Start the server
server.begin();
Serial.println("Server started");

// Print the IP address
Serial.print("Use this URL to
connect: ");
Serial.print("http://");
Serial.print(WiFi.localIP());
Serial.println("/");
}
```

```
void loop() {
    // Check if a client has connected
    WiFiClient client =
        server.available();

    if (!client) {
        return;
    }

    // Wait until the client sends
    some data
    Serial.println("new client");
    while(!client.available()) {
        delay(1);
    }
}
```

```
// Read the first line of the request
String request = client.readStringUntil('\r');
Serial.println(request);
client.flush();

// Match the request
int value = LOW;
if (request.indexOf("/LED=ON") != -1) {
    digitalWrite(ledPin, HIGH);
    value = HIGH;
}
if (request.indexOf("/LED=OFF") != -1) {
    digitalWrite(ledPin, LOW);
    value = LOW;
}
```

```
// Set ledPin according to the request
```

```
//digitalWrite(ledPin, value);
```

```
// Return the response
```

```
client.println("HTTP/1.1 200 OK");
```

```
client.println("Content-Type: text/html");
```

```
client.println(""); // do not forget this one
```

```
client.println("<!DOCTYPE HTML>");
```

```
client.println("<html>");
```

```
client.print("Led pin is now: ");
```

```
if(value == HIGH) {
```

```
    client.print("On");
```

```
} else {
```

```
    client.print("Off");
```

```
}
```

```
client.println("<br><br>");
```

```
client.println("Click <a  
href=\" /LED=ON\"> here</a> turn the  
LED on pin 2 ON<br>");
```

```
client.println("Click <a  
href=\" /LED=OFF\"> here</a> turn the  
LED on pin 2 OFF<br>");
```

```
client.println("</html>");
```

```
delay(1);
```

```
Serial.println("Client disconnected");
```

```
Serial.println("");
```

```
}
```