# “ESP32-Based Environmental Analysis Dashboard”

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS

OF THE DEGREE OF

**Bachelor of Technology in Computer Science and Engineering (IoT and Cyber Security with Blockchain Technology)**

By

**STUDENT NAME:**Riya vaghasiya **SAP ID:**60019230090

**STUDENT NAME:**Prisha Furia **SAP ID:** 60019230093

**STUDENT NAME:**Tiya Shah **SAP ID:** 60019230111

**STUDENT NAME:**Rujuta Mumbarkar **SAP ID:**60019230068



**Department of Computer Science and Engineering**

**(IoT and Cyber Security with Blockchain Technology)**

SVKM's Dwarkadas Jivanlal Sanghvi College of Engineering

(Autonomous College Affiliated to the University of Mumbai)

No.U-15, J.V.P.D. Scheme, Bhaktivedanta Swami Marg, Opp.Cooper Hospital,

Vile Parle (West), Mumbai-400 056. India

**Academic Year 2025-2026**

# EMBEDDED-INTERNET OF THINGS LABORATORY

**ESP32-Based Environmental Analysis Dashboard**

Submitted in Partial fulfilment of the requirements of,E-IOT

Laboratory (DJS23BLPC501) (SemV) in the Department of Computer Science &

Engineering (IoT and Cyber security with Blockchain Technology)

by

|  |  |
| --- | --- |
| **STUDENT NAME:**Riya vaghasiya | **SAP ID:**60019230090 |
| **STUDENT NAME:**Prisha Furia | **SAP ID:** 60019230093 |
| **STUDENT NAME:**Tiya Shah | **SAP ID:** 60019230111 |
| **STUDENT NAME:**Rujuta Mumbarkar | **SAP ID:**60019230068 |
|  |  |
|  |  |
|  |  |
|  |  |

**Prof.** Dipti Kale

**Date:**

**Academic Year 2025-2026**

# Declaration

We declare that any and all sources utilized in the preparation of this report have been properly cited and referenced. The ideas, concepts, and research findings presented in this proposal are entirely our own, unless otherwise acknowledged and referenced. This report represents my genuine efforts to contribute to the field of Computer Science Engineering ((IoT and Cyber security with Blockchain Technology) and to advance scholarly knowledge in a meaningful and ethical manner

**STUDENT NAME:**Riya vaghasiya **SAP ID:**60019230090

**STUDENT NAME:**Prisha Furia **SAP ID:** 60019230093

**STUDENT NAME:**Tiya Shah **SAP ID:** 60019230111

**STUDENT NAME:**Rujuta Mumbarkar **SAP ID:**60019230068

Date:



**and Cybersecurity with Blockchain Technology)**  **Department of Computer Science and Engineering (IoT**

# Certificate

This is to certify that, topic entitled “esp32-based environmental analysis dashboard” has been reviewed and evaluated by undersigned members, and is submitted as partial fulfilment E-IOT Laboratory(DJS23BLPC501) (Semester-V) in the Department of Computer

Science and Engineering (IoT and Cybersecurity with Blockchain Technology)

Dipti Kale \_

Prof.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dr. Narendra Shekokar Dr. Hari Vasudevan  (Vice Principal & Head of Department) (Principal)

## Abstract

UThis report details the development of an **ESP32 microcontroller-based Web Server** designed for real-time environmental monitoring and analysis. The system utilizes a DHT11 sensor to capture raw temperature and humidity data. The core innovation lies in the **real-time calculation and visualization of derived metrics**, specifically the **Heat Index** and **Dew Point**, alongside basic sensor readings. The result is a user-friendly, locally hosted web page that displays current conditions, analytical data, and graphical representations, demonstrating the ESP32's capabilities in data processing and IoT application development.

## INTRODUCTION

The Internet of Things (IoT) environment demands efficient, low-cost solutions for collecting and interpreting physical data. This project addresses this need by deploying the powerful **ESP32 System-on-Chip (SoC)** as a standalone Wi-Fi web server. Unlike basic monitoring systems that only display raw sensor data, this project transforms that raw data into meaningful **environmental indices**, providing a higher level of analytical output accessible via any web browser on the local network.

### Motivation

The primary motivations for this project are academic and practical:

* **Academic Rigor:** To demonstrate proficiency in key embedded systems concepts, including Wi-Fi networking, HTTP protocol communication, sensor integration, and **on-device data processing** (calculating derived metrics).
* **Enhanced Utility:** Simple temperature/humidity readings are insufficient for applications like **HVAC control** or **agriculture**. The Heat Index better represents human comfort and stress, while the Dew Point is critical for controlling condensation and predicting fog or moisture-related crop diseases.
* **Modern Interface:** To showcase a professional, clean, and graphically rich user interface using HTML/CSS and **Google Charts**, moving beyond basic text-based serial output.

## OBJECTIVE

The project achieved the following specific objectives:

1. **Establish reliable Wi-Fi Connectivity:** Successfully configure the ESP32 as a station and host an HTTP web server on the local network.
2. **Sensor Integration:** Accurately read **Temperature ($T$)** and **Relative Humidity ($H$)** from the DHT11 sensor.
3. **Data Analysis:** Implement and execute two critical derived metric functions:
   * **Calculate Heat Index:** Determine the 'feels like' temperature based on $T$ and $H$.
   * **Calculate Dew Point:** Determine the saturation temperature, indicating absolute moisture content.
4. **Web Interface Development:** Generate a dynamic, single-page HTML dashboard to display all four metrics and a relevant application quote.
5. **Data Visualization:** Incorporate **Google Charts** to visualize the raw readings using Gauges and Bar Charts.

## IMPLEMENTATION

The implementation utilizes the Arduino IDE framework for the ESP32. Key parts of the C++ code include:

**5.1. Setup and Networking**

* The setup() function initializes Serial communication and connects the ESP32 to the specified Wi-Fi network using WiFi.begin().
* The system then starts the web server on port 80 using server.begin().

**5.2. Derived Metric Functions**

Two dedicated functions are implemented to handle the necessary mathematical computations, demonstrating modular programming:

| **Metric** | **Function** | **Calculation Basis** |
| --- | --- | --- |
| **Heat Index** | calculateHeatIndex(T\_c, H\_p) | Simplified Celsium formula, relevant for temperatures $\ge 26.7^\circ \text{C}$. |
| **Dew Point** | calculateDewPoint(T\_c, H\_p) | **Magnus-Tetens Approximation**, which uses the natural logarithm ($\ln$) for high accuracy. |

**5.3. Web Server Loop (loop())**

1. **Client Connection:** server.available() checks for incoming HTTP requests.
2. **Sensor Read:** The DHT11 is read inside the request loop to ensure the data is fresh (dht11.read()).
3. **Data Processing:** The raw byte readings (temperature, humidity) are cast to float variables (T\_c, H\_p) and passed to the calculation functions.
4. **HTML Generation:** A large String variable (html) is constructed, concatenating HTTP headers, CSS, the main content (metrics and analysis), and the JavaScript for charting. All metric values (String(temperature), heatIndex\_display, etc.) are converted to strings and **injected dynamically** into the HTML payload.
5. **Response:** client.print(html) sends the complete webpage back to the client browser.

## RESULT /OUTPUT

**6.1. Metrics Display**

The output is a visually organized web page accessible via the ESP32's IP address. It displays four key metrics:

1. **Air Temperature:** $\text{T}^\circ \text{C}$ (Raw)
2. **Relative Humidity:** $\text{H}\%$ (Raw)
3. **Heat Index:** $\text{T}\_{\text{HI}}^\circ \text{C}$ (Calculated, shows thermal stress)
4. **Dew Point:** $\text{T}\_{\text{DP}}^\circ \text{C}$ (Calculated, shows absolute moisture)

**6.2. Analysis and Application**

A dedicated **Analysis & Interpretation** section explains the meaning of the derived metrics:

* The relationship between **Heat Index** and Air Temperature explains thermal comfort.
* The **Dew Point** is interpreted in terms of potential condensation and mugginess.
* **Crop Health Quote:** A specific quote is included to contextualize the importance of humidity control in agricultural applications.

**6.3. Visualization**

Two Google Charts provide visual feedback:

* **Temperature Gauge:** A dial showing the current temperature range and stress zones (Yellow/Red).
* **Humidity Bar Chart:** A simple bar representing the current humidity level against the $0\% \text{ to } 100\%$ scale.

## CONCLUSION

The developed ESP32-based environmental monitoring dashboard successfully meets all project objectives. It is a robust, low-cost system that effectively demonstrates the power of embedded processing by **converting raw sensor data into actionable analytical indices (Heat Index and Dew Point)**. The modern, responsive web interface, coupled with clear data interpretation and relevant application context (like the crop health quote), elevates the project from a simple data logger to a practical analytical tool suitable for use in smart homes, laboratories, or educational settings. This project serves as a strong foundation for more complex IoT applications involving data logging and predictive modeling.