PROJECT ABSTRACT

IoT Soil pH Monitor for Precision Agriculture

An ESP32-based field node that measures soil pH, moisture and temperature with a two-point buffer calibration and publishes field data to a farm dashboard. Delivered built-to-order with working prototype, firmware, calibration kit procedure, report, PPT and viva kit.

01. Title

IoT Soil pH Monitor for Precision Agriculture

02. Introduction / Background

Soil pH is the gatekeeper of fertilizer efficiency: in the 6.0–7.5 band most crops absorb nutrients freely, while strongly acidic or alkaline soils lock nutrients out no matter how much fertilizer is applied. Farmers who never test pH waste input cost and blame the seed for poor yields. Laboratory testing is accurate but slow and charged per sample, so testing rarely happens. This project puts a calibrated pH measurement in the field itself — an ESP32 node with an analog pH probe, moisture and temperature context, and a dashboard that keeps the seasonal record.

03. Problem Statement

Cheap ‘soil pH meters’ sold online are uncalibrated sticks with no documentation, and students who build pH projects often skip calibration entirely — the exact question examiners ask first. The project addresses this by making two-point buffer calibration the centerpiece: the firmware, procedure and report all treat calibration as the measurement, with the dashboard presenting only honestly-sourced numbers.

04. Objectives

- Measure soil pH continuously with an analog glass-electrode probe and conditioning board.
- Implement a genuine two-point calibration with pH 4.0 and 7.0 buffer solutions.
- Log soil moisture and temperature alongside pH for agronomic context.
- Publish per-node readings to a cloud dashboard with history and threshold alerts.
- Design for battery field operation with deep sleep and optional solar top-up.
- Deliver the complete student kit: prototype, firmware, calibration guide, report, PPT and viva Q&A.;

05. Proposed Methodology

The node is built around the ESP32 reading the pH board's analog output, a capacitive moisture sensor and a waterproof DS18B20. Firmware implements the two-point calibration routine, scheduled wake-measure-publish-sleep cycles, and Wi-Fi publishing to a ThingSpeak/Blynk-class dashboard. The enclosure is weatherproofed for field use. The student performs the buffer calibration and a field measurement campaign, recording both in the report.

06. System Architecture / Working

After calibration, the node wakes on its schedule, reads pH, moisture and temperature, and publishes the packet with its node ID over Wi-Fi. The dashboard appends readings to per-node history and charts pH trends; crossing the configured acidic or alkaline thresholds raises an alert. Between readings the node sleeps to conserve battery, targeting weeks of field operation on a charge (design target).

07. Hardware / Software Requirements

- ESP32 development board (Wi-Fi)
- Analog soil pH probe + conditioning board
- Capacitive soil moisture sensor
- Waterproof DS18B20 temperature probe
- pH 4.0 and 7.0 buffer solutions
- Cloud dashboard (ThingSpeak/Blynk class)
- Li-ion battery with optional solar panel
- Arduino IDE (C/C++ firmware)

08. Expected Outcomes

- A field node reporting calibrated soil pH with moisture and temperature context.
- A dashboard with per-node pH history and threshold alerts.
- A documented two-point calibration performed by the student.
- A complete report, PPT and viva Q&A; on soil chemistry, probe calibration and IoT field design.

09. Applications

- Precision-agriculture demonstrations and agri-tech coursework.
- Teaching analog sensor calibration and battery field-node design.
- Seasonal soil-monitoring studies on college farms.

10. Future Scope

- LoRa backhaul for fields without Wi-Fi coverage.
- NPK sensor fusion for a fuller soil-fertility picture.
- Fertilizer recommendation logic built on the logged data.
- Solar-powered multi-node mesh for large farms.