# SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR

# Electronic Design Workshop Project Instruction Manual

(5TH SEM, SESSION 2025-2026, ECP5005)

## "IoT based Hazardous Gas Detection and Alert System for Mines"

Submitted By Batch: A2

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## Department of Electronics and Communication Engineering

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## Department of Electronics and Communication Engineering

CERTIFICATE

This is to certify that the project report titled "IoT based Hazardous Gas Detection and Alert System for Mines" is a bona fide work of:

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Submitted as a part of term work in 5th semester in Electronic Design Workshop (ECP5005) during the academic session 2025-2026.

Date: 1/12/2025
Place: Nagpur

Name & Signature
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# Contents

## *1. System Overview*

Our IoT-based solution designed to detect hazardous gases in underground mines using a self-healing multi-hop network. Each sensor node monitors methane ($CH_4$), carbon monoxide (CO), carbon dioxide ($CO_2$), hydrogen sulfide ($H_2S$), and environmental conditions, transmitting data wirelessly to a central server.

## *2. Safety Instructions*

**WARNING:**

- This system is a prototype and should not be used as the primary safety system in active mines

- Always follow established mine safety protocols alongside this system

- Regular calibration of gas sensors is essential for accurate readings

## *3. Hardware Components*

### *3.1 Sensor Node Components:*

- ESP32 Microcontroller

- Gas Sensors: MQ4 ($CH_4$), MQ7 (CO), MQ135 ($CO_2$), MQ136, DHT11 (Temp/Humidity)

- Power: Two 18650 batteries (2200mAh each)

- Charging Circuit: TP4056 with MT308 Boost Converter (to 5V)

- Alert: Buzzer for local alarms

- Enclosure: Protective housing for mine deployment

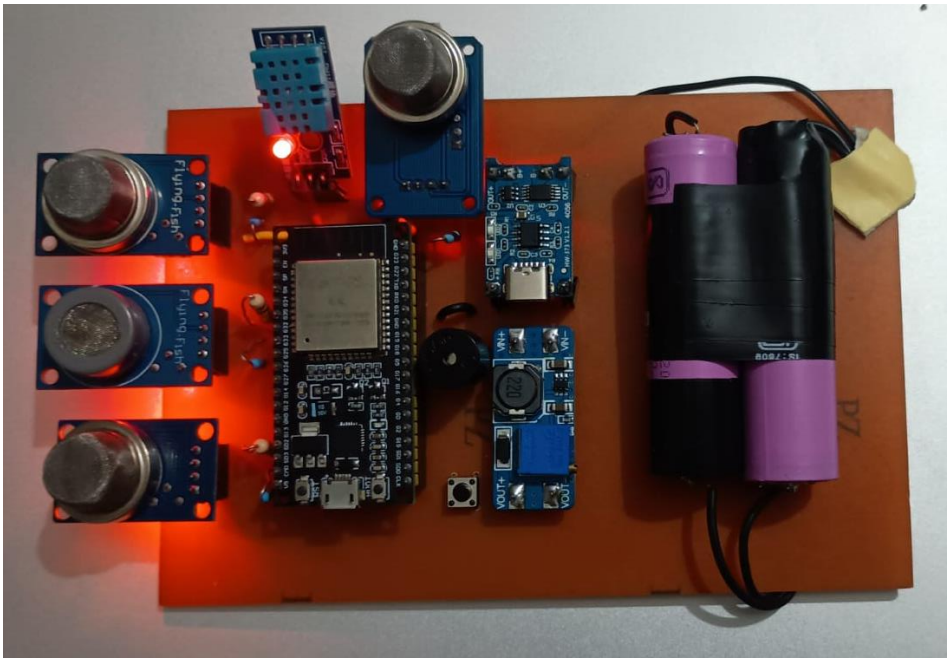


Fig.1: Sensor Node

*3.2 Server Node:*

- ESP32 with continuous power supply

- Wi-Fi connectivity for data aggregation

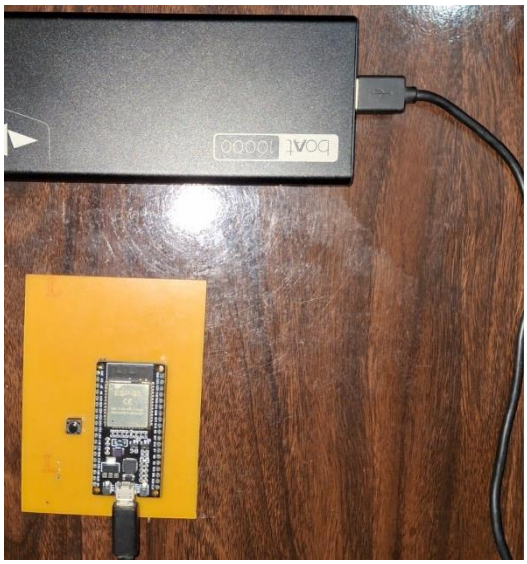

Fig.2: Server Node

## *4. Installation Guide*

4.1 Sensor Node Placement:

1. Mount nodes on mine walls at breathing height (4-6 feet)
2. Ensure clear air flow around sensors
3. Place nodes within theoretical range (20-30 meters apart)
4. Avoid placing near ventilation exhausts or dead air spaces

4.2 Power Setup:

1. Charge batteries fully using TP4056 charger
2. Connect batteries in parallel to boost converter
3. Verify 5V output before connecting to ESP32
4. Seal enclosure properly to protect from dust/moisture

## *5. System Operation*

### *5.1 Startup Procedure:*

1. Power ON server node first
2. Power ON sensor nodes sequentially
3. Wait for network discovery
4. Verify all nodes appear in server logs

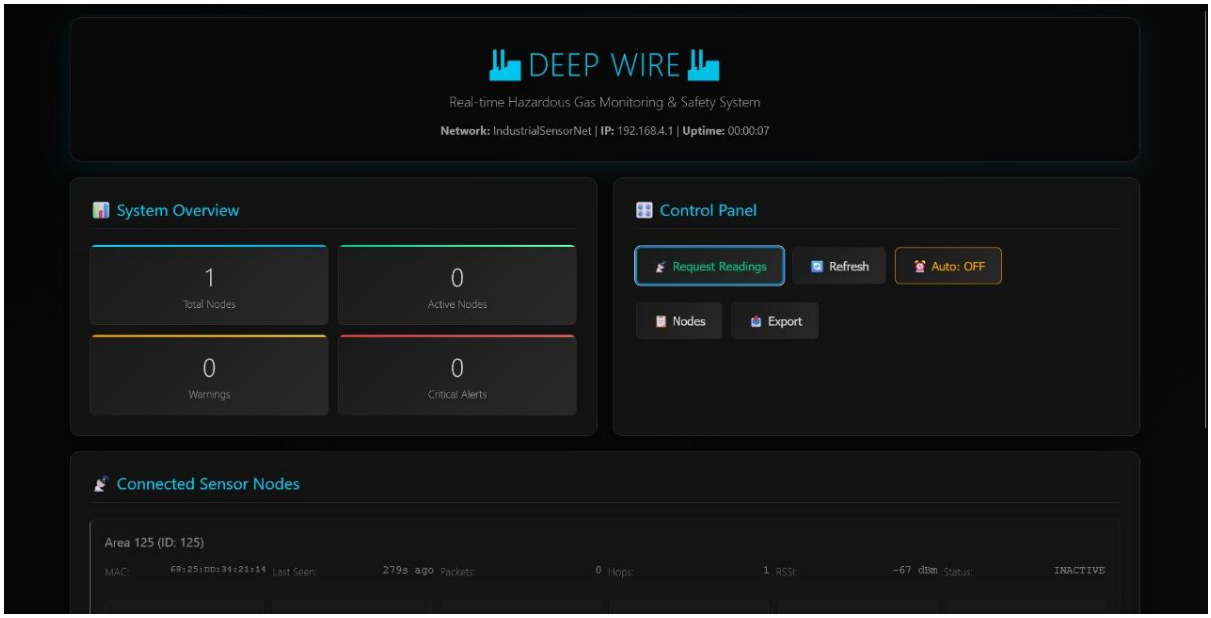


Fig.3: Web Dashboard

*5.2 Normal Operation:*

- Nodes transmit data every 5 minutes

- Network automatically handles node discovery and routing

*5.3 Alert Conditions*

- Local Buzzer: Sounds immediately when gas thresholds exceeded

- Priority Transmission: Alert data sent immediately, bypassing 5-minute interval

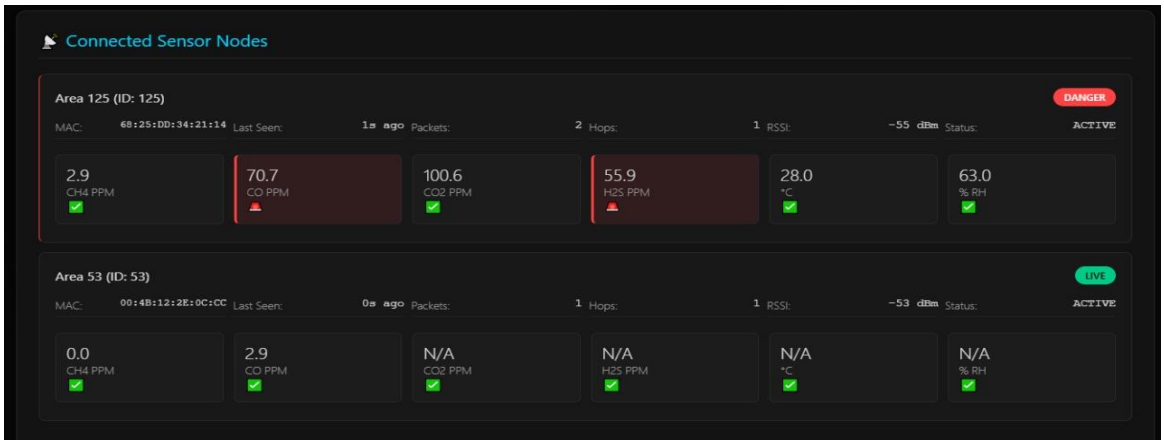


Fig.4: Danger Detected

## *6. Network Configuration*

### *6.1 ESP-NOW Protocol:*

- Uses peer-to-peer communication
- No Wi-Fi network required for node-to-node communication
- Server node requires Wi-Fi for cloud connectivity (if implemented)

### *6.2 Multi-Hop Algorithm:*

Normal Condition: Node → Server

Weak Signal: Node → Intermediate Node → Server

Network Failure: Node searches for nearest available neighbor

## *7. Data Management*

### 7.1 Data Collection:

- Sensor readings stored locally on server
- Data exportable to Excel format
- Timestamp included with all readings

### 7.2 Threshold Settings:

**(Include your specific threshold values)**

- Methane ($CH_4$): _____ ppm
- Carbon Monoxide (CO): _____ ppm
- Carbon Dioxide ($CO_2$): _____ ppm
- Hydrogen Sulfide ($H_2S$): _____ ppm
- Temperature: _____ °C

## 8. Maintenance Schedule

8.1 Daily:

- Check battery levels and node status indicators
- Verify server is receiving data from all nodes

8.2 Weekly:

- Physical inspection of all nodes for damage
- Clean sensor surfaces from dust accumulation

8.3 Monthly:

- Full battery recharge/replacement
- Sensor calibration check
- Network performance verification

## *9. Troubleshooting Guide*

*1. Node Not Transmitting*

Possible Cause: Low battery power

Solution: Recharge or replace the batteries

*2. No Data Received*

Possible Cause: Network connection lost

Solution: Restart the node and check its placement/position

*3. False Alarms*

Possible Cause: Sensors are contaminated or dirty

Solution: Clean the sensors thoroughly and recalibrate them

*4. Buzzer Not Sounding*

Possible Cause: Loose or faulty wiring connections

Solution: Check and secure all buzzer wiring connections

## *10. Technical Specifications*

- Power Consumption: 2W-4W per node
- Battery Life: 4-8 hours continuous operation
- Communication Range: ~65 meters (mine conditions)
- Operating Temperature: -10°C to 50°C
- Data Transmission Interval: 5 minutes (normal), Immediate (alerts)