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Assignment:	2
Course Name:	IOT
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Section A

1. What is Thing Speak and why is it used in IoT applications?

ThingSpeak is a cloud-based platform designed for real-time visualization of IoT sensor data. It enables efficient monitoring of devices by assigning separate channels to each project

2. How does MQTT differ from HTTP in terms of communication for IoT devices?

MQTT is a lightweight protocol based on the publish-subscribe model, making it ideal for live data exchange. In contrast, HTTP relies on request-response and is less suitable for continuous data communication.

3. Why is multi-core tasking important in an ESP32-based IoT system?

ESP32 has two cores, which allows it to handle multiple tasks at the same time like reading sensor data while uploading it without delays or interruptions.

4. What is a mutex/lock, and why is it needed when updating an OLED display concurrently?

A mutex (mutual exclusion) is used to avoid conflicts when multiple tasks try to access the same resource. It prevents the OLED display from getting corrupted data when updated by different processes.

5. Name two features of Firebase that make it suitable for real-time sensor data logging.

- Real-time database that syncs instantly across devices
- Easy REST API integration with microcontrollers like ESP32

6. What is InfluxDB, and why is it preferred over traditional databases for IoT data?

InfluxDB is a time-series database designed for storing timestamped data. It's ideal for IoT because it efficiently handles frequent, time-based sensor readings.

7. Define time-series data and give one example from this assignment.

Time-series data consists of values recorded at regular time intervals. Example:

Logging temperature and humidity from a DHT22 sensor to InfluxDB every 5 seconds.

8. **What is the purpose of NTP synchronization in IoT systems?** NTP (Network Time Protocol) syncs the system time on devices like ESP32 to ensure accurate timestamps for data logging and time-sensitive operations.

Section B

9. ESP32 to ThingSpeak Flow Design:

- **Step-by-step flow:**
  - Connect ESP32 to Wi-Fi. ○ Read data from DHT22 sensor.
  - Format data and include the ThingSpeak **API key**.
  - Send an HTTP GET request with data to ThingSpeak's URL.

code:

python CopyEdit

connect_to_wifi()

read_temp_humid()

url = "https://api.thingspeak.com/update?api_key=XXXX&field1=temp&field2=humid" send_http_request(url)

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10. Arduino-C vs MicroPython

Feature	**Arduino (C++)**	**MicroPython**
Ease of Use	Harder syntax	Easier, Pythonic syntax
Performance	Faster, low-level control	Slightly slower
Hardware Control	Deep hardware access	Some limitations
Ecosystem Support	Huge community, many libraries	Growing, but smaller ecosystem

Learning Curve	Steep for beginners	Friendly for AI/CS students

11. Firebase Data Flow Design:

- **Flow:**
  - ESP32 syncs time via **NTP**.
  - Reads sensor data (temp/humidity).
  - Formats data into **JSON**:

{ "temp": 25, "humidity": 60, "timestamp": "2025-06-01T12:00:00Z" } ○

Sends to Firebase using HTTP with secure **authentication**.

  - Firebase stores and displays in real-time.

12. Environmental Classification (Python + InfluxDB)

- **Steps:**
  1. Fetch data from InfluxDB using influxdb-client-python.
  2. Preprocess (clean nulls, normalize).
  3. Train model (e.g., Decision Tree or KNN) on temp/humidity.
  4. Predict environment class (e.g., "Hot", "Comfortable").
  5. Write result back to InfluxDB for visualization.
- **Snippet:**

```
from sklearn.tree import DecisionTreeClassifier
model.fit(X_train, y_train) predictions =
model.predict(new_data)
write_to_influxdb(predictions)
```

Section C:

13. End-to-End IoT Architecture Comparison

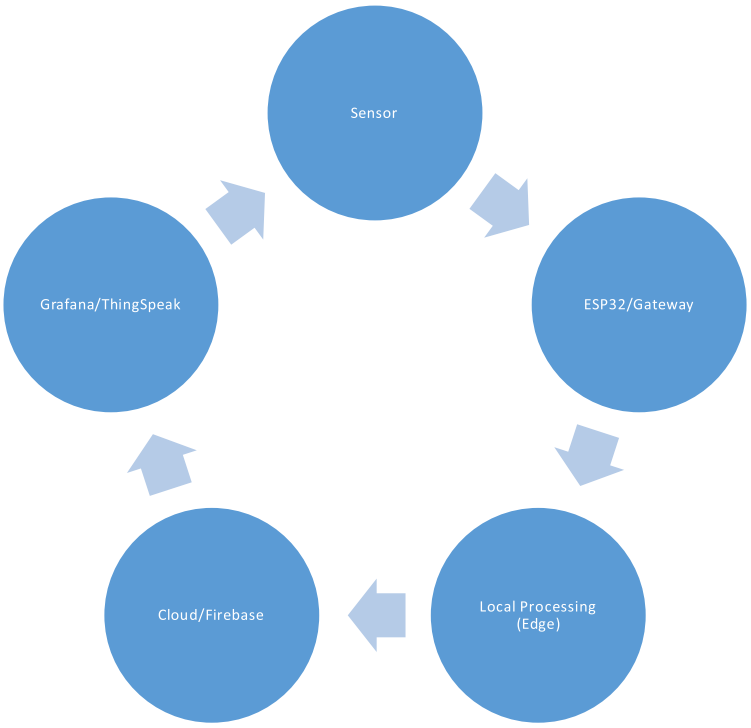
(a) Gateway-based vs Cloud-based Model

Aspect	**Gateway Model (Edge)**	**Cloud Model**
Processing	Done locally on device/gateway	Done on cloud servers
Latency	Very low	Higher due to network delays
Deployment	More complex	Easier (just send to cloud)
Scalability	Limited by hardware	Easily scalable

(b) ## IoT System Layers and Components:

Layer	**Example Components**
Sensing	DHT22, Soil Moisture Sensor
Communication	Wi-Fi, MQTT, HTTP
Storage	Firebase, InfluxDB
Visualization	ThingSpeak, Grafana
DecisionMaking	ML model on ESP32 or cloud-based alerts

Diagram



Bonus Q14

AI-Based Environmental Prediction (Edge Computing)

- AI models can be trained on past temperature/humidity data.
- The trained model (e.g., Decision Tree) can be stored on ESP32.
- When new data arrives, prediction is done **on-device**.
- This reduces delay and keeps the system fast, even offline.
- Edge inference saves bandwidth and improves real-time actions.
- Cloud can still be used for logging and retraining models.
- Apps include smart farming (e.g., irrigation alerts), HVAC systems, or home automation.