Questions and Solutions

Sol. a) Swarm drones refer to a group of drones that operate together as a coordinated unit, mimicking the behavior of natural swarms like bees or birds. These drones communicate with each other to perform tasks collaboratively and efficiently. Here are the key aspects of swarm drones:

1. **Decentralized Control:** In a swarm, no single drone has overall control. Each drone follows simple rules based on local information and decisions.

2. **Communication:** Drones share information with each other in real-time, which allows them to adjust their actions dynamically based on the behavior of the swarm. This communication can involve sharing positions, velocities, and sensor data.

3. **Autonomy:** Each drone operates autonomously, making decisions based on its own sensors and pre-programmed rules. This means they can continue functioning even if they lose connection with other drones.

4. **Scalability:** Swarm systems are easily scalable. You can add more drones to the system without requiring significant changes to the overall operation.

5. **Robustness:** The failure of a single drone does not significantly impact the mission, as other drones in the swarm can continue the task and compensate for the

loss.

Sol. b) The ESP8266 is a low-cost Wi-Fi microchip that can be used for wireless communication in drones, allowing them to communicate with the controller and with each other. Here's how we can integrate ESP8266 with a drone's flight controller:

1. **Hardware Connection:**

- Connect the ESP8266 module to the flight controller:
- Use the UART (Universal Asynchronous Receiver-Transmitter) interface for connection. Connect the TX (transmit) pin of the ESP8266 to the RX (receive) pin of the flight controller and the RX pin of the ESP8266 to the TX pin of the flight controller.
- Ensure the ESP8266 is powered correctly, typically with 3.3V.

2. **Software Configuration:**

- *Flash the ESP8266:* Load the firmware onto the ESP8266 that supports communication protocols such as MQTT (Message Queuing Telemetry Transport) or a custom protocol suitable for the drones' communication needs.
- *Program the Flight Controller:* Write the code for the flight controller to send and receive data via the UART interface. This code will handle commands and data exchange between the flight controller and the ESP8266.
- *Implement Communication Protocol:* Develop a communication protocol to enable drones to share status, position, and sensor data. This protocol

ensures that all drones can effectively coordinate their actions and avoid collisions.

3. **Integration:**

- *Set Up Wi-Fi Network:* Configure the ESP8266 to establish a Wi-Fi network or connect to an existing network. All drones should be connected to the same network to facilitate seamless communication.
- *Test Communication:* Conduct tests to ensure that the ESP8266 modules on all drones can communicate effectively with each other and the central controller.

Sol. c) Suggested Design Changes for Regular Drones

To enhance the functionality and efficiency of regular drones for the given task, the following design changes can be considered:

1. **Improved Battery Life:**

- *Change:* Integrate higher capacity batteries or more efficient power management systems.
- *Justification:* Longer battery life will allow drones to cover larger areas and perform longer missions without needing frequent recharges.
- *References:* [Improving UAV Battery Life](https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=10208231)

2. **Enhanced Sensors:**

- *Change:* Upgrade to more accurate LIDAR and color sensors for precise detection and identification of

objects.

- *Justification:* Higher accuracy in sensors will improve the drone's ability to identify and differentiate between objects, enhancing mission success.
- *References:* [Advanced LIDAR Systems](https://www.mdpi.com/2504-446X/3/1/1)

3. **Robust Communication System:**

- *Change:* Implement a more reliable and secure communication system using advanced modules like ESP8266 or LoRa (Long Range).
- *Justification:* A robust communication system ensures consistent and reliable data exchange between drones, critical for swarm operations and mission coordination.
- *References:* [Reliable UAV Communication Systems](https://www.researchgate.net/publication/342303003_Unmanned_Aerial_Vehicle_UAV_Inter-Communication_Optimization_Technique)

4. **Optimized Design for Weight Reduction:**

- *Change:* Use lightweight materials and streamline the drone design to improve aerodynamics and reduce energy consumption.
- *Justification:* Reducing the drone's weight enhances flight efficiency, allowing for longer flight times and better maneuverability.
- *References:* [Lightweight UAV Materials](https://www.researchgate.net/publication/362390002_High-Performance_Materials_used_for_UAV_Manufacturing_Classified_Review)

These changes aim to optimize the drones' performance, making them more suitable for complex and extended missions while ensuring efficient operation and reliable communication within the swarm.