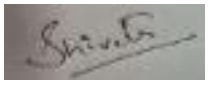
Department of Computer Science Engineering

Details of Lesson Plan

S.No.	Particulars	Details
1.	Course Name	UAV/Drone Technologies
2.	Course Code	COM-802(A)
3.	Academic Year	2024-2025
4.	Semester	8th
5.	Number of Lesson plans	43
6.	Faculty Assigned	Ms. Shiveta Bhat



Faculty Signature

Lesson Plan No. 0	Course Name: UAV/Drone Technologies Introduction to UAV/Drone Technologies	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the fundamentals of drone technology, its history, and industrial applications. b. Identify various drone components and their roles in flight operations. c. Analyze drone software, control mechanisms, and flight dynamics. d. Explore drone navigation systems, synchronization methods, and practical implementations. e. Examine drone algorithms for flight control, navigation, and obstacle avoidance.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - **Ask questions to engage students:** • What are drones, and how have they evolved over time? • How do drones impact industries such as agriculture, construction, and defense? • What are some key technological advancements in drone technology? - **Historical Background of Drone Technology:** • Evolution from military applications to commercial and industrial use. • Types of drones: Fixed-wing, Rotary-wing, Hybrid. • Key features and industry-specific applications. - Discuss course outcomes. **Development** (30 minutes) - **Why Drone Technology Matters?** - Importance of drones in modern industries. - Benefits of drones: - Resource efficiency. - Enhanced surveillance and data collection. - Connectivity and automation. - Real-world applications of drones in agriculture, cinematography, and delivery services. - **Drone Components and Systems** - **Hardware Components:** - Frame, Motors, Propellers, Batteries.

	- Importance of aerodynamics in drone design. - **Sensors and Navigation:** - GPS, Accelerometers, Gyroscopes, Cameras. - Flight stabilization and real-time data processing. - **Software and Control Mechanisms** - **Drone Flight Dynamics:** - Principles of flight (Lift, Drag, Thrust). - Flight stabilization and control systems. - **Navigation and Synchronization:** - GPS-based navigation. - Autonomous flight and obstacle avoidance. - AI integration in drone navigation. - **Future Trends in Drone Technology (10 Minutes)** - AI-powered drones and IoT integration. - Urban Air Mobility (UAM) and drone deliveries. - Government regulations and ethical considerations. - Emerging career opportunities in drone technology. - **Certifications and Career Prospects:** - Drone Pilot Certification. - UAV Engineering and Maintenance. - AI and Robotics in Drone Applications. - Online Courses: Coursera, Udemy, LinkedIn Learning. - - **YouTube Video:** "The Evolution of Mobile Networks: From 1G to 5G" **https://youtu.be/rNsQ0fJs9so**
Closure	1. Summarize the lesson, correlating with learning outcomes 2. Encourage students to explore further reading and online resources **Suggested Reading:** 1. *Introduction to UAV Systems* by Paul Fahlstrom, Chapter 1, pp. 1-17. 2. *Drones: The Complete Guide to Airborne Robotics* by Casey Kuhlman, Chapter 2, pp. 35-50. 3. *Unmanned Aircraft Systems: UAVs Design, Development, and Deployment* by Reg Austin, Chapter 3, pp. 60-85. 4. *Autonomous Drone Navigation: Algorithms and Techniques* by A. Roberts, Chapter 5, pp. 120-140.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** How has drone technology evolved over the years? **2.** What are the key challenges in drone navigation and control? **3.** How do AI and swarm technologies influence drone applications? Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 1	Course Name: UAVs and Drone Technology Topic: Basics of drone technology and its historical background	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Articulate the basic concept of drone technology and its components. b. Explain the evolution of drone technology. c. Illustrate the various applications of drone technology. d. Appreciate the advantages of drone technology in real-life applications
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Introduce the basics of drone technology. - Discuss the evolution of drone technology. - Talk about different types of drones available in the market today. - Define drone technology formally. - Highlight the importance of drone technology in daily life. **Development** (30 minutes) **a. Drone Technology** - Introduce the concept of drone technology. - Show a video on the evolution of drone technology. - Explain the key components of drones (e.g., frame, propellers, motors, battery, sensors, and controllers). - Discuss different categories of drones (e.g., military, commercial, consumer, and industrial drones). b. **Applications and Benefits** - Illustrate various applications of drone technology (e.g., surveillance, delivery services, agriculture, cinematography, disaster management). - Discuss the advantages of drone technology: o Efficiency and speed in transportation and surveillance. o Cost-effectiveness in various industries. o Enhanced safety in hazardous environments. c. **Interfacing and Utilities** - Highlight the importance of drone technology interfacing with other systems (e.g., IoT, AI, GPS, cloud computing). - Discuss utilities and tools associated with drone technology (e.g., drone control software, remote controllers, flight simulation applications). **Exercise (5 minutes)** - Exercise (5 minutes) – Give students time to discuss the various applications and benefits

	of drone technology.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/rNsQ0fJs9so 3. Homework Ask students to make a chart explaining the evolution of drone technology, discussing advancements in features over time. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What are the essential components of a drone system? **2.** Why is drone technology critical for modern industries and applications? **3.** Who benefits the most from advancements in drone technology? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 2	Course Name: UAVs and Drone Technology Topic: Types of drones and their applications in different industries	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Identify different types of drones and their classifications. b. Illustrate the benefits and limitations of drones in different sectors. c. Appreciate the role of drones in modern industry and technology.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Introduce the different types of drones and their classifications. - Discuss the significance of drones in various industries. - Talk about the major advancements in drone technology. - Define drone technology and its relevance in industrial applications. - Highlight the impact of drones on automation and efficiency. **Development** (30 minutes) - a. **Types of Drones** - Explain different categories of drones based on size, purpose, and operational capabilities (e.g., fixed-wing, rotary-wing, hybrid, nano drones). - Discuss the differences between consumer, commercial, military, and industrial drones. - b. **Applications in Various Industries** - Illustrate how drones are used in different sectors: - **Agriculture**: Precision farming, crop monitoring, pesticide spraying. - **Construction**: Site surveying, progress monitoring, safety inspections. - **Healthcare**: Medical supply delivery, disaster relief aid. - **Logistics & Delivery**: Package delivery, last-mile transportation. - **Military & Defense**: Surveillance, reconnaissance, tactical operations. - **Environmental Monitoring**: Wildlife tracking, disaster response, pollution control. - **Entertainment & Media**: Aerial photography, live broadcasting, filmmaking. - c. **Interfacing and Utilities** - Highlight how drones integrate with modern technology (e.g., AI, IoT, cloud computing, GPS). - Discuss tools and software used for drone operations (e.g., drone control systems, data analytics, flight planning software).

	- **Exercise (5 minutes)** - Exercise (5 minutes) – Give students time to discuss how drones are transforming different industries
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/L53Sz1p21B0 3. Homework Ask students to prepare a short presentation on the role of drones in a specific industry of their choice. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What are the different types of drones and their primary uses? **2.** Why are drones becoming increasingly important in various industries? **3.** Who benefits the most from drone technology advancements? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 3	Course Name: UAVs and Drone Technology Topic: Current trends, and prospects of drone technology.	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the latest advancements in drone technology. b. Identify key trends driving the evolution of drone applications. c. Discuss the future potential and challenges of drone technology. d. Appreciate the role of emerging technologies in shaping drone applications.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define drone technology and its rapid evolution. - Highlight the significance of drones in various industries. - Discuss how advancements in AI, connectivity, and automation are enhancing drone capabilities. **Development** (30 minutes) **a. Current Trends in Drone Technology** - **AI and Machine Learning Integration:** Drones with AI-driven object detection, predictive analytics, and automated decision-making. - **Autonomous Drones:** Self-piloted drones for delivery, security, and surveillance. - **Extended Battery Life & Renewable Energy Drones:** Solar-powered drones and longer flight times. - **Swarm Technology:** Coordinated drone fleets for search-and-rescue, agriculture, and military operations. - **5G and IoT-Enabled Drones:** Real-time data transmission and cloud-based analytics. - **Regulatory Developments:** Global policies shaping commercial drone use and airspace regulations. **b. Future Prospects of Drone Technology** - **Urban Air Mobility (UAM):** Drone taxis and passenger drones in smart cities. - **Medical and Emergency Response:** Drones for rapid healthcare delivery and disaster relief. - **Space Exploration:** Drone applications in planetary research and remote sensing. - **Advanced Military & Defense Applications:** AI-enhanced combat drones and strategic surveillance. - **Environmental Conservation:** Drones for pollution monitoring, afforestation, and wildlife tracking. **Exercise (5 minutes)**

	- Exercise (5 minutes) – Give students time to how drones may impact industries in the next decades.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/g86XUvCcIS8 3. Homework Ask students to write a short report on how drones will transform a specific sector by 2035. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What are the latest trends in drone technology? **2.** Why is AI integration crucial for the future of drones? **3.** Who will benefit most from advanced drone applications? **4.** What are the potential challenges in large-scale drone deployment? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 4	Course Name: UAVs and Drone Technology Topic: Drone applications in industries such as agriculture	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the latest advancements in drone technology in agriculture. b. Identify key trends driving the evolution of drone applications in farming. c. Discuss the future potential and challenges of drone technology in agriculture.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define drone technology and highlight its rapid evolution in the context of agriculture. - Discuss how drones have transformed agricultural practices by providing new capabilities like crop monitoring and precision farming. - Briefly introduce the role of artificial intelligence, Internet of Things (IoT), and connectivity in enhancing the functionality of agricultural drones. **Development** (30 minutes) **a. Current Trends in Drone Technology for Agriculture:** - **AI and Machine Learning Integration:** Drones equipped with AI for crop monitoring, pest detection, and predictive analytics for better decision-making. - **Precision Agriculture:** Drones used for precise spraying of pesticides, herbicides, and fertilizers based on real-time data. - **Autonomous Drones:** Drones that operate independently, mapping fields, identifying problems, and performing tasks without human intervention. - **Extended Battery Life & Renewable Energy Drones:** Drones using solar power or efficient battery technology for extended flight times and better operational cost-effectiveness. - **5G and IoT-Enabled Drones:** Drones using 5G for faster data transmission, enabling real-time crop and field monitoring, IoT sensors integrated into drones to analyze soil and crop health. - **Regulatory Developments:** Exploration of global policies shaping drone usage in agriculture, focusing on airspace regulations and drone licensing. **b. Future Prospects of Drone Technology in Agriculture**

	- **Urban and Vertical Farming:** Drones for monitoring urban farms and indoor vertical farming systems. - **Automated Harvesting:** Future drones may be able to autonomously identify and harvest crops, optimizing labor usage in farming. - **Drone Swarms for Crop Management:** Multiple drones working together to monitor and manage large-scale fields, enabling efficient coverage and fast analysis. - **Sustainability and Environmental Monitoring:** Drones for tracking the health of ecosystems, monitoring pollution levels, and supporting afforestation initiatives. - **Drone-Assisted Livestock Management:** Drones for monitoring livestock, tracking animal health, and managing grazing patterns. **Exercise (5 minutes)** - Exercise (5 minutes) – Ask students to reflect on how drones might impact the agricultural industry in the next 10 years. Have them consider aspects like sustainability, food security, and precision agriculture.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/g86XUvCcIS8 3. Homework Ask students to write a short report on how drones will transform a specific sector of agriculture (e.g., crop monitoring, livestock management, irrigation) by 2035. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What are the latest trends in drone technology for agriculture? **2.** Why is AI integration important for the future of drones in farming? **3.** Who will benefit most from the advanced applications of drones in agriculture? **4.** What challenges might farmers face with large-scale drone deployment? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 5	Course Name: UAVs and Drone Technology Topic: Drone applications in industries such as construction	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the latest advancements in drone technology for construction. b. Identify key trends driving the evolution of drone applications in the construction industry. c. Discuss the future potential and challenges of drone technology in construction.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define drone technology and discuss its increasing integration into the construction industry. - Introduce key benefits of drones in construction: enhanced safety, improved efficiency, reduced labor costs, and better data accuracy. - Discuss how technologies like AI, IoT, and automation are advancing drone functionalities for construction purposes. **Development** (30 minutes) **a. Current Trends in Drone Technology for Construction:** - **Site Surveying and Mapping:** Drones equipped with GPS and photogrammetry tools for creating accurate 2D and 3D maps of construction sites, enabling more efficient planning. - **Building Information Modeling (BIM):** Integration of drones with BIM to provide real-time data that can be used for design, planning, and construction phase management. - **Aerial Inspections:** Drones used for inspecting hard-to-reach areas like roofs, facades, and structural components to ensure safety and quality control. - **Construction Progress Monitoring:** Drones provide real-time aerial imagery and video footage to monitor the progress of construction projects, ensuring they stay on schedule and within budget. - **Materials Tracking and Delivery:** Drones help track inventory, monitor material usage, and even deliver small materials to specific points on the construction site. - **Safety Monitoring:** Drones equipped with thermal imaging and other sensors help monitor construction site conditions, detect hazards, and ensure compliance with safety standards.

	b. Future Prospects of Drone Technology in Construction: - **Automated Construction Processes:** Drones will collaborate with robotics for automated construction, such as material handling and assembly of structural elements. - **Construction of Smart Cities:** Drones will play a key role in building and monitoring smart infrastructure, including traffic management and energy-efficient buildings. - **Advanced Inspection Techniques:** With the addition of AI, drones will be capable of identifying structural flaws, wear and tear, and offering predictive maintenance suggestions. - **Faster and More Efficient Construction:** Drones may revolutionize the speed of construction with enhanced material transport, monitoring, and documentation processes. - **Environmental Monitoring and Sustainability:** Drones will monitor environmental impacts, track resource usage, and ensure sustainable building practices are followed on construction sites. **Exercise (5 minutes)** **c.** Exercise (5 minutes) – Ask students to brainstorm how drones might change the way specific construction tasks (e.g., site surveying, materials delivery) are performed in the next decade.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/V0oqSWSkoB4 3. Homework Ask students to research a real-world construction project that successfully used drones and write a short report on how drones were implemented and the benefits realized. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1. What** are some key applications of drones in construction? **2. Why** are drones considered crucial for safety and efficiency in construction? **3. Who** benefits the most from drone technology in construction? **4. What** are some of the challenges that could hinder the widespread adoption of drones in the industry? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 6	Course Name: UAVs and Drone Technology Topic: Drone applications in industries such as cinematography	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the role of drones in modern cinematography. b. Identify key trends in the use of drones for film production. c. Discuss the future potential and challenges of drone technology in cinematography.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define drone technology and its role in cinematography, especially in terms of capturing aerial shots and innovative cinematographic techniques. - Discuss how drones have revolutionized film production by offering creative shots, reducing costs, and enhancing visual storytelling. Briefly mention the integration of advanced features such as AI, stabilization systems, and live video feeds in cinematography drones. **Development** (30 minutes) **a. Current Trends in Drone Technology for Cinematography** - **Aerial Cinematography:** Drones are used to capture sweeping aerial shots that would be impossible or cost-prohibitive with traditional equipment (e.g., helicopters, cranes). - **Precision Control:** Advanced flight control systems allow cinematographers to have precise control over the drone's movements, ensuring smooth and stable shots even in dynamic scenes. - **Camera Stabilization:** Gimbals and other stabilization systems are integrated into drones, allowing for smooth footage despite drone movements or external forces such as wind. - **First-Person View (FPV) Drones:** Drones with FPV systems allow cinematographers to experience a live, immersive perspective, which is particularly useful in action shots or complex, fast-moving scenes. - **Real-Time Data Transfer and Monitoring:** Drones equipped with live video feeds and real-time data transfer allow directors and cinematographers to monitor footage on-site, facilitating immediate adjustments. - **Special Effects Integration:** Drones are increasingly used in combination with CGI (Computer Generated Imagery) to create visually stunning effects in films, TV shows, and

	advertisements. - **Safety and Cost Efficiency:** Drones are safer and more cost-effective than traditional equipment (e.g., helicopters, cranes), reducing production costs while still offering high-quality cinematography. **b. Future Prospects of Drone Technology in Cinematography:** - **Enhanced AI and Autonomous Filming:** Drones with AI capabilities could autonomously follow actors or objects, capturing intricate and dynamic shots without human input. - **360-Degree and Virtual Reality (VR) Filming:** Drones equipped with 360-degree cameras will become more common, enabling immersive VR experiences and new forms of storytelling. - **Cinematic Drone Swarms:** Multiple drones flying in sync may be used to create dynamic, multi-angle shots that could add a new level of creativity and depth to cinematography. - **Integration with Augmented Reality (AR):** Drones could be used for real-time AR integration during live filming, enhancing the visual effects and interaction between live actors and CGI elements. - **Sustainability in Filmmaking:** Drones may replace traditional fuel-heavy equipment like helicopters, reducing the carbon footprint of film production and contributing to greener filmmaking practices. **Exercise (5 minutes)** **a.** Exercise (5 minutes) – Ask students to think about how drones could be used in different types of films (e.g., action, documentary, horror). Have them brainstorm specific drone shots or sequences that could enhance the storytelling or cinematography.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/xJfst6hLEKs 3. Homework Ask students to research a recent film or music video that prominently features drone cinematography. Have them write a short report on the drone shots used, their impact on the film, and the challenges involved in capturing such shots. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What are some advantages of using drones in cinematography compared to traditional filming methods?

	2. Why are drones particularly useful in capturing complex or dynamic shots? **3.** Who benefits the most from drone cinematography in the film industry? **4.** What are some challenges filmmakers might face when using drones in cinematography? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 7	Course Name: UAVs and Drone Technology Topic: Understanding drone hardware components: frame	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the role of the drone frame in the overall structure and functionality of the drone. b. Identify the different types of drone frames and materials used in their construction. c. Discuss the key considerations for selecting a drone frame based on purpose and performance.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define the concept of a drone frame and its importance in the overall drone design. - Introduce the key functions of the drone frame: providing structural support, holding critical components, and ensuring durability. - Briefly explain how the frame affects factors like flight performance, weight, stability, and aerodynamics. - **Development** (30 minutes) **a. Types of Drone Frames:** - Quadcopters (and other Multi-rotor Drones) - Fixed-Wing Drones - Hexacopters and Octocopters - Custom and Specialty Frames **b. Materials Used in Drone Frames:** - Plastic (Polycarbonate, ABS) - Carbon Fiber - Aluminum - Fiberglass **c. Key Considerations for Choosing a Drone Frame (5 minutes):** - Weight vs. Durability: - Size and Design Requirements - Ease of Repair and Customization

	- Aerodynamics **Exercise (5 minutes)** **a.** Exercise (5 minutes) – Ask students to compare the advantages and disadvantages of different drone frame materials (e.g., carbon fiber vs. plastic vs. aluminum) for a specific application (e.g., racing drone vs. aerial photography drone).
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/xJfst6hLEKs 3. Homework Ask students to design a simple drone frame for a specific task (e.g., photography, surveying, or racing). They should outline the material selection, size, and reasons for their choices based on the requirements of the task. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What factors should be considered when choosing the right frame for a drone? **2.** Why is material selection important in drone frame construction? **3.** Who would benefit from understanding drone frame design in the context of professional drone operations? **4.** What challenges might arise in designing a custom drone frame? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 8	Course Name: UAVs and Drone Technology Topic: Understanding drone hardware components: motors	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the role of motors in drone flight and their interaction with other components. b. Identify the different types of motors used in drones and their respective characteristics. c. Discuss how motor specifications (e.g., KV rating, size, and thrust) affect drone performance. d. Appreciate how motor selection impacts factors like efficiency, flight time, and stability.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define the role of motors in drone systems, explaining how they provide the necessary thrust to lift and propel the drone. - Highlight the importance of motors in achieving efficient flight control, stability, and maneuverability. - Briefly introduce the concept of brushless motors and brushed motors, explaining their different uses in drone applications. **Development** (30 minutes) **a. Types of Drone Motors** - **Brushed Motors (DC Motors):** - Explain how brushed motors work and their components: the rotor, stator, and brushes. - Discuss the advantages: cost-effective, easy to control, and suitable for small hobby drones. - **Brushless Motors (BLDC Motors):** - Describe how brushless motors differ from brushed motors, including the absence of brushes and the use of an electronic speed controller (ESC). - **b. Motor Specifications** - **KV Rating (RPM per Volt):** - Explain what KV rating refers to: the number of revolutions per minute (RPM) a motor makes for every volt supplied. - **Size of the Motor (Diameter and Length):** - Discuss how the motor's size (diameter and length) affects thrust capacity and overall drone stability. - **Thrust and Efficiency:** - Explain how motor thrust is a critical factor in determining

	how much weight a drone can lift and its overall flight performance. - **c. Motor Selection and Drone Performance (5 minutes):** - **Motor and Propeller Matching:** - Explain the relationship between motor selection and propeller size: larger motors work better with larger propellers, while smaller motors work best with smaller propellers. - **Flight Time and Stability:** - Explain how the motor's efficiency impacts flight time and battery life. Motors with higher efficiency produce more thrust without consuming too much power, extending the drone's flight time. **Exercise (5 minutes)** **a.** Exercise (5 minutes) – Ask students to analyze the specifications of two motors with different KV ratings and sizes. Have them identify which motor would be better suited for a drone designed for racing and which would be ideal for an aerial photography drone. Ask them to justify their choices based on performance and efficiency requirements.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/jOugJpQfUDU 3. Homework Ask students to select a drone motor for a specific type of drone (e.g., a high-performance racing drone or a heavy-lift drone for aerial photography) and provide an explanation for their choice, taking into account the motor's KV rating, size, and thrust. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 1. **What** factors should be considered when selecting a motor for a specific drone type? 2. **Why** is the KV rating an important consideration for motor selection? 3. **Who** would benefit from understanding the specifications of drone motors in terms of design and performance? 4. **What** are the main differences between brushed and brushless motors? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 9	Course Name: UAVs and Drone Technology Topic: Understanding drone hardware components: propellers	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the role of propellers in drone flight. b. Identify the different types of drone propellers and their characteristics. c. Discuss how propeller size, pitch, and material affect drone performance.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define the role of propellers in drone systems and explain how they work to generate lift and thrust for drone movement. - Introduce the concepts of thrust and torque, and how propellers contribute to balancing the forces that enable stable flight. - Briefly mention the factors influencing propeller performance, including size, pitch, and material. - **Development** (30 minutes) **a. Types of Propellers** - Two-Blade Propellers - Three-Blade Propellers - Multi-Blade Propellers (Four or More Blades) **b. Propeller Specifications:** - Size (Diameter) - Pitch - Material (Plastic, Carbon Fiber, Wood) o Plastic Propellers o Carbon Fiber Propellers o Wooden Propellers **c. How Propeller Size, Pitch, and Material Affect Performance:** - Impact on Flight Stability - Impact on Efficiency and Flight Time - Noise and Vibration **Exercise (5 minutes)**

	Provide students with different propeller options (e.g., two-blade, three-blade, and four-blade) with varying pitch and size. Ask them to choose the best propeller for a specific application (e.g., long-range survey drone vs. racing drone) and justify their decision based on the drone's required stability, efficiency, and payload.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/sYXX5snCwL4 3. Homework Ask students to write a short report on how they would select propellers for a drone intended for an aerial photography mission, considering size, pitch, and material. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What factors should be considered when selecting propellers for a drone? **2.** Why is pitch an important consideration when choosing propellers? **3.** Who would benefit most from understanding propeller performance and design in the context of professional drone applications? **4.** What impact does propeller material have on drone performance and durability. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 10	Course Name: UAVs and Drone Technology Topic: Understanding drone hardware components: batteries	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the role of batteries in drone operation. b. Identify different types of drone batteries and their characteristics. c. Discuss the factors affecting battery life and performance in drones. d. Appreciate the importance of battery selection and management for safe and efficient drone flight.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Introduce the concept of battery technology and its essential role in powering drones. - Discuss how the energy stored in a battery is converted into electrical power for the motors, sensors, and other components of the drone. - Highlight the significance of battery life, weight, and efficiency in drone performance. **Development** (30 minutes) **a. Types of Drone Batteries (15 minutes):** - **Lithium-Polymer (LiPo) Batteries:** o Most commonly used in drones due to their high energy - **Lithium-Ion (Li-ion) Batteries:** o Known for their higher energy density and longer lifespan than LiPo batteries. - **Nickel-Metal Hydride (NiMH) Batteries:** o Less commonly used but found in some budget drones. - **Solid-State Batteries (Emerging Technology):** o A new battery technology that promises even higher energy density and better safety than LiPo and Li-ion. **b. Key Battery Specifications and Their Impact (10 minutes):** - **Voltage (V):** o Voltage is crucial for determining the amount of power the battery can deliver to the drone's motors and components. - **Capacity (mAh or Ah):** o Capacity is the amount of energy the battery can store, measured in milliampere-hours (mAh) or ampere-hours (Ah). - **C-Rating (Discharge Rate):** o The C-rating indicates the maximum discharge rate a battery can handle without damage.

	- **Weight:** o Battery weight is critical because it directly impacts the overall weight of the drone. **c. Factors Affecting Battery Life and Performance (5 minutes):** - Temperature - Discharge Cycles - Overcharging and Over-discharging - Charging Speed and Methods **Exercise (5 minutes)** Have students compare two drones: one with a LiPo battery and one with a Li-ion battery. Ask them to analyze how the battery type affects the drone's performance, flight time, and payload capacity. Students should consider factors such as weight, flight time, and voltage compatibility with the drone's motors..
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/TebqYmTIFJk 3. Homework Ask students to write a short report on the potential impact of solid-state batteries on drone technology in the next decade. Discuss their advantages, challenges, and potential applications. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What factors should be considered when choosing a battery for a drone? **2.** Why is temperature management critical for battery performance and safety? **3.** Who benefits most from understanding drone battery technology (e.g., drone manufacturers, hobbyists, or commercial drone operators)? **4.** What are the risks associated with improper battery handling or charging? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 11	Course Name: UAVs and Drone Technology Topic: Introduction to drone sensors	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the role of sensors in drone operation. b. Identify different types of sensors used in drones and their functions. c. Discuss the importance of sensor data in autonomous and manual drone flights
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Introduce the concept of drone sensors and their essential role in gathering data for navigation and control. - Explain how sensors provide real-time feedback to ensure stability, obstacle avoidance, and efficient flight operations. - Highlight the significance of sensor integration in modern drone applications, including photography, surveying, and delivery services. **Development** (30 minutes) **Types of Drone Sensors** **-Inertial Measurement Unit (IMU):** o Includes accelerometers and gyroscopes for measurng motion and orientation. - **GPS (Global Positioning System):** o Enables precise positioning and navigation. - **LiDAR (Light Detection and Ranging):** o Used for mapping and obstacle detection. - **Ultrasonic Sensors:** o Assist in altitude control and landing precision. - **Optical Flow Sensors:** o Help in stable hovering and low-altitude navigation. - **Infrared Sensors:** o Used for thermal imaging and night vision applications. - **Magnetometer:** o Helps in determining drone orientation relative to the Earth's magnetic field. b. **Importance of Sensor Data in Drone Operations** - **Flight Stability:** o How IMU and GPS help maintain a steady flight. - **Obstacle Avoidance:** o The role of LiDAR, ultrasonic, and infrared sensors in preventing collisions. - **Navigation and Positioning:**

	○ The importance of GPS and magnetometer in precise flight control. - **Autonomous Flight:** ○ How drones use multiple sensors for self-navigation. - **Factors Affecting Sensor Performance (5 minutes)** • Environmental conditions (weather, temperature, interference) • Sensor calibration and maintenance • Power consumption and efficiency **Exercise (5 minutes)** • Have students compare two drones: one with basic sensors (IMU, GPS) and one with advanced sensors (LiDAR, Optical Flow). • Ask them to analyze how the sensors affect the drone's stability, navigation accuracy, and obstacle avoidance.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/P9adBgSz--g 3. Homework Ask students to write a short report on the future of drone sensors and how AI-powered sensors can improve autonomous navigation. Discuss their advantages, challenges, and potential applications. Spend 5 minutes to wrap up and consolidate the learnings.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What factors should be considered when selecting sensors for a drone? **2.** Why is sensor calibration important for accurate drone operation? **3.** Who benefits most from advanced drone sensors (e.g., surveyors, military, or delivery companies)? **4.** What are the risks of relying too much on sensors in autonomous drones? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 12	Course Name: UAVs and Drone Technology Topic: Introduction to drone sensors like GPS	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the role of GPS in drone operation. b. Explain how GPS enables precise positioning and navigation in drones. c. Discuss the factors affecting GPS accuracy and performance in drone flights. d. Appreciate the importance of GPS integration for safe and efficient drone operation.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Introduce the concept of GPS (Global Positioning System) and its significance in drone navigation. - Explain how GPS provides real-time location data, enabling drones to determine their position accurately. - Highlight the importance of GPS for waypoint navigation, geofencing, and return-to-home functions in drones. **Development** (30 minutes) How GPS Works in Drones (15 minutes): • Satellite Connectivity: o GPS relies on signals from multiple satellites to triangulate the drone's exact location. • Positioning and Navigation: o The GPS module calculates latitude, longitude, and altitude for accurate drone control. • Geofencing and Return-to-Home (RTH): o GPS enables pre-defined flight boundaries and automatic return in case of low battery or signal loss. b. Factors Affecting GPS Accuracy (10 minutes): • Number of Satellites Connected: o More satellites provide better positioning accuracy. • Interference from Buildings and Trees: o GPS signals can be blocked or weakened by obstacles. • Weather Conditions: o Heavy clouds, storms, and atmospheric disturbances can impact GPS signal reception. • Dual-Frequency GPS: o Advanced drones use dual-frequency GPS (L1/L2) for enhanced accuracy and reliability.

	c. Applications of GPS in Drone Operations (5 minutes): • Surveying and Mapping • Search and Rescue Missions • Agricultural Monitoring • Aerial Photography and Videography **Exercise (5 minutes)** • Have students compare a drone using GPS with one that relies solely on manual control. • Ask them to analyze how GPS enhances flight stability, automated navigation, and safety. • Students should consider factors such as accuracy, ease of operation, and flight reliability.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/wCcARVbL_Dk 3. Homework Ask students to write a short report on the future of GPS in drone technology. Discuss advancements like RTK (Real-Time Kinematics) and AI-enhanced GPS systems. Spend 5 minutes to wrap up and consolidate the learnings.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What factors should be considered when selecting a GPS module for a drone? **2.** Why is GPS important for autonomous drone navigation? **3.** Who benefits most from GPS-enabled drones (e.g., surveyors, emergency responders, or delivery services)? **4.** What are the risks associated with GPS signal loss during a drone flight? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 13	Course Name: UAVs and Drone Technology Topic: Introduction to drone sensors like accelerometers	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the role of accelerometers in drone operation. b. Explain how accelerometers help in maintaining drone stability and motion sensing. c. Discuss the factors affecting accelerometer accuracy and performance in drones.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Introduce drone sensors and their role in autonomous and stable flight. - Explain that an **accelerometer** is a sensor that measures changes in velocity (acceleration) to detect movement and orientation. - Discuss why accelerometers are essential for **stabilization, flight control, and obstacle detection** in drones. **Development** (30 minutes) How Accelerometers Work in Drones Measurement of Acceleration: o Accelerometers measure acceleration along three axes (X, Y, Z) to detect movement and tilting. • Stabilization and Orientation: o They work with gyroscopes to maintain drone balance and counteract external forces like wind. • Data Processing: o The flight controller continuously processes accelerometer data to make real-time adjustments for smooth and stable flight. b. Factors Affecting Accelerometer Accuracy • Vibration and External Forces: o Excessive vibration from motors can introduce errors in acceleration readings. • Calibration and Drift: o Regular calibration is required to ensure precise movement detection. • Temperature Variations: o Extreme temperatures can affect sensor sensitivity and performance. • Multi-Axis Sensing:

	○ Advanced drones use 3-axis or 6-axis accelerometers for better motion detection and response. **c.** Applications of Accelerometers in Drone Operations • Flight Stabilization and Hovering • Obstacle Avoidance and Collision Prevention • Automated Takeoff and Landing • Gesture-Based Control and Motion Detection **Exercise (5 minutes)** • Compare the flight performance of a drone with an accelerometer vs. one without it. • Analyze how accelerometers improve stability, precision, and responsiveness. • Discuss real-world examples where accelerometers are critical in drone operation.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/KuekQ-m9xpw 3. Homework Write a short report on **how MEMS (Microelectromechanical Systems) accelerometers are revolutionizing drone technology**. Discuss their role in AI-driven autonomous drones and future advancements. Spend 5 minutes to wrap up and consolidate the learnings.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What are the main functions of an accelerometer in drones? **2.** Why is an accelerometer important for flight stability? **3.** Who benefits most from advanced accelerometer technology in drones (e.g., hobbyists, commercial users, researchers)? **4.** What are the risks of inaccurate accelerometer readings in drone flight? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 14	Course Name: UAVs and Drone Technology Topic: Introduction to drone sensors like gyroscopes	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the role of gyroscopes in drone operation. b. Explain how gyroscopes help in maintaining drone stability and orientation. c. Discuss the factors affecting gyroscope accuracy and performance in drones.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Introduce drone sensors and their significance in stable flight. - Explain that a **gyroscope** is a sensor that measures angular velocity (rotational movement) to detect changes in orientation. - Discuss why gyroscopes are essential for **stabilization, navigation, and precise control** in drones. **Development** (30 minutes) How Gyroscopes Work in Drones • Measurement of Angular Velocity: o Gyroscopes detect rotational movements along three axes (Pitch, Roll, Yaw). • Stabilization and Orientation: o They help drones adjust flight angles in real-time to maintain balance and stability. • Data Processing: o The flight controller uses gyroscope data to make real-time corrections, preventing unwanted tilting and drifts. b. Factors Affecting Gyroscope Accuracy • Drift and Calibration: o Over time, gyroscopes develop drift errors, requiring frequent calibration. • External Interference: o Vibrations, sudden movements, or electromagnetic interference can affect accuracy. • Temperature Sensitivity: o Extreme temperatures impact the performance and responsiveness of gyroscopes. • Integration with Other Sensors: o Gyroscopes work best when paired with accelerometers for enhanced motion sensing. c. Applications of Gyroscopes in Drone Operations

	• Flight Stability and Orientation Control • Precise Navigation and Positioning • Obstacle Avoidance and Collision Prevention • Autonomous Flight and AI-based Control Systems **Exercise (5 minutes)** - Compare the flight stability of a drone **with a gyroscope** vs. one **without it**. - Analyze how gyroscopes improve **drone maneuverability, stability, and precision**. - Discuss real-world applications of gyroscopes in **military drones, photography drones, and delivery drones**.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/KuekQ-m9xpw 3. Homework Write a short report on **how MEMS (Microelectromechanical Systems) accelerometers are revolutionizing drone technology**. Discuss their role in AI-driven autonomous drones and future advancements. Spend 5 minutes to wrap up and consolidate the learnings.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1. What** is the primary function of a gyroscope in drones? **2. Why** is a gyroscope essential for drone flight stability? **3. How** does a gyroscope differ from an accelerometer in a drone? **4. What** are the risks of inaccurate gyroscope readings in drone flight? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 15	Course Name: UAVs and Drone Technology Topic: Introduction to drone sensors like camera	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the role of cameras in drone operation. b. Explain how cameras enable drones to capture images and videos. c. Discuss the factors affecting camera quality and performance in drones. d. Appreciate the importance of cameras in various drone applications.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Introduce the importance of sensors in drones and their role in gathering data. - Explain that a **camera is a crucial sensor** in drones used for capturing real-time images and videos. - Discuss different types of cameras used in drones: **RGB cameras, thermal cameras, multispectral cameras, and LiDAR**. **Development** (30 minutes) How Drone Cameras Work • Image and Video Capture: o Drone cameras capture high-resolution images and record videos for monitoring, mapping, and surveillance. • Stabilization & Gimbal System: o Most drones use gimbals (2-axis or 3-axis) to stabilize the camera for smooth footage even during movement. • Live Streaming & FPV (First-Person View): o Many drones allow real-time video transmission to controllers or smartphones. b. Factors Affecting Camera Performance • Resolution & Sensor Size: o Higher megapixels and larger sensors provide better image quality. • Frame Rate & Video Quality: o 4K cameras provide superior video clarity compared to 1080p. • Lighting Conditions & Night Vision: o Some cameras have low-light capabilities, infrared (IR)

	sensors, or thermal imaging for night operations. • Field of View (FOV): ○ Wide-angle lenses offer broader coverage, while zoom lenses help in detailed inspection. c. Applications of Drone Cameras • Aerial Photography & Videography (Film, Events, Sports, News) • Surveillance & Security (Border Monitoring, Disaster Management, Police Use) • Agriculture (Crop Monitoring, Disease Detection) • Delivery Drones (Navigation and Object Recognition) **Exercise (5 minutes)** - Compare footage from **a drone with a stabilized camera vs. one without stabilization**. - Discuss how camera resolution and lens type affect **image clarity and application use**. - Ask students to research how AI-powered cameras help drones in **autonomous navigation**.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/CpLdL8ONEm4 3. Homework Write a short report on the future of drone cameras in industries like healthcare, construction, and logistics. Spend 5 minutes to wrap up and consolidate the learnings.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What are the key factors that affect drone camera performance? **2.** Why are gimbals important for drone cameras? **3.** How do thermal and multispectral cameras enhance drone applications? **4.** What are the limitations of using cameras as sensors in drones? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 16	Course Name: UAVs and Drone Technology Topic: Overview of drone software and control	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the role of drone software in flight control, navigation, and mission planning. b. Explain how different software components enable autonomous drone operations. c. Identify key drone communication systems and data transmission methods. d. Discuss the applications and challenges of drone control software in various industries.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Briefly introduce the importance of software in drones for control, navigation, and automation. - Explain that drones rely on software-driven flight control systems (FCS) and AI-based automation. - Mention three major categories of drone software: - Flight Control Software (FCS) - Navigation and Positioning Systems - Mission Planning and Automation **Development** (30 minutes) - **Flight Control Software** - Role of FCS in stabilizing and controlling drones. - Explain open-source (PX4, ArduPilot) vs. proprietary (DJI, Autel Robotics) FCS. - Features: Stability, Altitude Control, Return-to-Home (RTH), Telemetry Monitoring. - **Navigation and Positioning Systems** - GPS & GNSS for global positioning. - IMU, LiDAR, and Visual SLAM for precise navigation. - AI-powered obstacle avoidance and object tracking. - **Communication & Data Transmission** - RC Systems, Telemetry Links, 5G/Wi-Fi for real-time drone control. - Drone-to-Cloud communication for live streaming and AI processing. - **Mission Planning & Automation** - Waypoint Navigation, AI-assisted obstacle avoidance, Swarm Intelligence. - Overview of Mission Planner, DroneDeploy, DJI GS Pro for

	automated missions. **Exercise (5 minutes)** - Compare manual vs. autonomous drone operation. - Discuss AI's role in drone software advancements.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/AP1UC0DlIrE 3. Homework Write a short report on the future of drone software in industries like healthcare, construction, and logistics. Spend 5 minutes to wrap up and consolidate the learnings.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What is the function of flight control software in drones? **2.** How does AI improve drone navigation? **3.** What are the main challenges of drone software? **4.** Why is real-time communication important? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 17	Course Name: UAVs and Drone Technology Topic: Drone Flight Dynamics	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the fundamental principles of drone flight dynamics. b. Describe how drones achieve stability and maneuverability. c. Discuss different flight modes and control mechanisms. d. Analyze real-world applications of drone flight dynamics.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define Drone Flight Dynamics as the study of how drones move and stay stable in the air. - Introduce the four main forces acting on a drone: - Lift (generated by propellers). - Weight (gravitational force pulling the drone down). - Thrust (forward motion due to propellers). - Drag (air resistance opposing motion). - **Development** (30 minutes) - **Principles of Drone Flight** - Explain how quadcopters maintain stability by adjusting propeller speed. - Discuss the role of gyroscopes and accelerometers in maintaining balance. - Explain Yaw, Pitch, and Roll as the three primary drone movements: - Yaw: Rotating left or right (turning). - Pitch: Tilting forward or backward (forward/backward movement). - Roll: Tilting side to side (left/right movement). - **Drone Stability and Maneuverability** - Explain PID (Proportional-Integral-Derivative) Control Systems for stability. - Discuss barometer, GPS, and vision sensors for altitude control. - Compare manual vs. autonomous drone stabilization techniques. - **Flight Modes and Control Systems** - Introduce common drone flight modes: - **Manual Mode** – Full control by the pilot.

	- **Altitude Hold Mode** – Drone maintains altitude automatically. - **GPS Mode** – Position is stabilized using satellite navigation. - **Follow Me Mode** – Drone follows a designated subject. - **Return-to-Home (RTH) Mode** – Drone automatically returns to its launch point. **Exercise (5 minutes)** - Compare the effects of Yaw, Pitch, and Roll using a small drone simulation or video. - Discuss how wind and weather impact drone flight stability. - Ask students to research the role of AI in modern drone stability.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/C0KBu2ihp-s 3. Homework Write a short report on how **AI and machine learning** improve drone flight control.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** How do propeller speeds affect drone stability? **2.** Why is GPS important for drone navigation? **3.** What challenges do drones face in harsh weather conditions? **4.** How does AI help drones maintain balance and avoid obstacles? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 18	Course Name: UAVs and Drone Technology Topic: Drone Flight Control	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the fundamental principles of drone flight control. b. Explain how different control systems (manual, autonomous, and assisted) work. c. Discuss the role of flight controllers, sensors, and actuators in drone stability. d. Identify different flight modes and their applications.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Introduce the concept of **drone flight control** and its importance in stable and autonomous operation. - Explain the **four primary forces** acting on a drone: **Lift, Weight, Thrust, and Drag**. - Briefly discuss the **three key movements** of drones: **Yaw, Pitch, and Roll**. - Highlight the importance of **flight controllers** in stabilizing drones. - **Development** (30 minutes) - **Components of Drone Flight Control** - Flight Controller (FC): Acts as the brain of the drone, processing sensor data and sending commands to motors. - Electronic Speed Controllers (ESCs): Control the motor speed based on input from the flight controller. - IMU (Inertial Measurement Unit): Includes an accelerometer and gyroscope for stability. - GPS Module: Enables positioning and navigation. - Barometer: Helps maintain altitude. - **Flight Modes & Control Systems** - Manual Mode: Pilot has full control (used in racing drones). - Stabilized Mode: Assists the pilot by automatically leveling the drone. - GPS Hold Mode: Keeps the drone in position using satellite data. - Altitude Hold Mode: Uses a barometer to maintain height. - Return-to-Home (RTH): Brings the drone back to the takeoff

	point autonomously. - **Autonomous Flight Control & AI Integration** - Waypoints Navigation: Pre-programmed flight paths using GPS coordinates. - Computer Vision-Based Control: AI-powered obstacle detection and tracking. - Swarm Drone Coordination: Multi-drone control for industrial and military applications. **Exercise (5 minutes)** - Discuss future trends like 5G-enabled drones, AI-powered decision-making, and improved battery technology.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/4dmrahCJonM 3. Homework Write a short report on how AI and machine learning improve drone flight control.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** Why is the flight controller crucial for a drone? **2.** What are the differences between manual and autonomous flight modes? **3.** How does GPS assist in drone navigation? **4.** What are the challenges of autonomous drone control? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 19	Course Name: UAVs and Drone Technology Topic: Principles of flight including aerodynamics	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Explain the four aerodynamic forces (Lift, Weight, Thrust, and Drag) and their role in flight stability. b. Describe the principles of Bernoulli and Newton in relation to lift generation and flight control. c. Analyze the effects of airfoil shape, angle of attack, and control surfaces on aircraft maneuverability.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define aerodynamics and its significance in flight. - Explain that flight occurs due to the interaction between air and the aircraft's structure. - Introduce the four forces of flight: Lift, Weight, Thrust, and Drag. - Briefly discuss airfoil design and airflow behavior around a wing. - **Development** (30 minutes) - **The Four Forces of Flight** - Lift (Upward Force) - Generated by the wing (airfoil) as air moves over and under the surface. - Bernoulli's Principle: Faster airflow over the curved upper surface reduces pressure, creating lift. - Newton's Third Law: The wing pushes air downward, generating an opposite reaction (lift). - Factors Affecting Lift: - Angle of Attack (AoA) – The angle between the oncoming air and the chord line of the wing. - Airfoil Shape – Determines how air flows over the wing. - Airspeed – Faster airflow increases lift. - Air Density – Higher density provides more lift. - Weight (Downward Force) - The gravitational pull acting on the aircraft.

	- Aircraft must generate sufficient lift to counteract weight for sustained flight. - Thrust (Forward Force) - Provided by propellers, jet engines, or turbofans to move the aircraft forward. - Increased thrust overcomes drag and enables acceleration. - Drag (Resisting Force) - The air resistance opposing the aircraft's motion. - Two types: - Parasite Drag – Caused by friction (fuselage, landing gear, antennas). - Induced Drag – Created by the production of lift (wingtip vortices). - Aircraft designs reduce drag through aerodynamic shaping and winglets. - **Bernoulli's Principle and Newton's Laws in Flight** - Bernoulli's Principle - Explains lift based on air pressure differences. - Faster air over the curved wing surface creates low pressure, pulling the wing upward. - Newton's Laws of Motion - First Law (Inertia): An aircraft stays in motion unless acted upon by another force. - Second Law (F=ma): Higher thrust leads to faster acceleration. - Third Law (Action-Reaction): Air is pushed downward, and the aircraft lifts upward. - **Airfoil Design, Angle of Attack, and Control Surfaces** - Airfoil Design - The curved shape of a wing determines airflow behavior and lift generation. - Leading Edge & Trailing Edge: Influence smooth airflow and reduce turbulence. - Angle of Attack (AoA) - Increasing AoA increases lift up to a critical point (stall angle). - Beyond the stall angle, airflow separates, and lift decreases, leading to a stall. - Control Surfaces and Their Functions - Ailerons (Roll Control): Controls tilt or banking of the aircraft. - Elevators (Pitch Control): Moves the nose up/down. - Rudder (Yaw Control): Turns the aircraft left or right. - Flaps & Slats: Used to increase lift during takeoff and landing. **Exercise (5 minutes)**

	Discuss Why do modern airplanes have winglets?
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/5ltjFEei3AI 3. Homework Write a short report on how drones use aerodynamics for stable flight.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** How does Bernoulli's Principle explain lift? **2.** What happens when an aircraft exceeds its critical Angle of Attack? **3.** Why do airplanes use flaps and slats during takeoff and landing? **4.** What are the differences between induced and parasite drag? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 20	Course Name: UAVs and Drone Technology Topic: Principles of flight including lift	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the concept of lift and its role in flight. b. Explain Bernoulli's Principle and Newton's Laws in relation to lift generation. c. Analyze the factors affecting lift, including airfoil shape, angle of attack, and airflow.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define lift as the force that enables an aircraft to rise and stay in the air. - Introduce the four forces of flight: Lift, Weight, Thrust, and Drag. - Emphasize that lift must counteract weight for flight to occur. - Briefly mention the role of airfoil design and airflow behavior. - **Development** (30 minutes) - **Understanding Lift** - Definition of Lift: - The upward aerodynamic force generated by airflow over a wing. - Opposes gravity (weight) to keep the aircraft in the air. - How Lift is Generated: - Air moving over the curved upper surface of the airfoil speeds up, reducing pressure. - Higher pressure under the wing pushes it upwards (Bernoulli's Principle). - Newton's Third Law: Air is deflected downward, creating an equal and opposite upward force. - **Bernoulli's Principle and Newton's Laws in Lift** - Bernoulli's Principle: - Faster airflow over the top of the wing creates low pressure, generating lift. - The pressure difference between the top and bottom of the wing causes the aircraft to rise. - Newton's Laws of Motion:

	- Third Law (Action-Reaction): The wing pushes air downward, and the aircraft is lifted upward. - Second Law (F=ma): Higher thrust increases speed, enhancing lift generation. - **Factors Affecting Lift** - Airfoil Shape: - Curved wings generate more lift than flat surfaces. - The leading edge and trailing edge influence airflow. - Angle of Attack (AoA): - The angle between the oncoming airflow and the wing's chord line. - Increasing AoA increases lift up to a critical point (stall angle). - Exceeding the stall angle causes airflow separation, leading to a stall (loss of lift). - Airspeed: - Faster-moving air over the wings increases lift. - Air Density: - Higher air density (lower altitude) increases lift, while thinner air (higher altitude) reduces lift. - **Exercise (5 minutes)** Discuss Why do different aircraft have different wing shapes?
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture 3. https://youtu.be/E3i_XHlVCeU Homework Write a short report on how drones maintain lift without traditional wings.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** How does Bernoulli's Principle explain lift? **2.** What happens when an aircraft exceeds its critical Angle of Attack? **3.** How does airspeed affect lift? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 21	Course Name: UAVs and Drone Technology Topic: Principles of flight including drag	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the concept of drag and its role in flight performance. b. Explain the types of drag (Parasite Drag, Induced Drag, Wave Drag) and their effects. c. Analyze the factors influencing drag and methods used to minimize it in aviation
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define drag as the aerodynamic force that opposes an aircraft's motion through the air. - Explain that drag acts in the opposite direction of thrust and must be minimized for efficient flight. - Introduce the four forces of flight: Lift, Weight, Thrust, and Drag. - Emphasize that reducing drag improves fuel efficiency and speed. - **Development** (30 minutes) - **Understanding Drag** - Definition of Drag: - Drag is the resistance force caused by air opposing an aircraft's forward motion. - It affects flight efficiency and fuel consumption. - How Drag is Generated: - Air molecules collide with the aircraft's surface, creating resistance. - Faster speeds generally increase drag unless aerodynamic optimization is used. - **Types of Drag** - Parasite Drag (Resists Forward Motion) - Caused by non-lifting components (fuselage, landing gear, antennas). - Increases with airspeed (faster aircraft experience more parasite drag). - Subtypes:

	- Form Drag – Due to aircraft shape and cross-section. - Skin Friction Drag – Caused by air rubbing against the aircraft's surface. - Interference Drag – Occurs where different surfaces meet (e.g., wing-fuselage junction). - Induced Drag (Lift-Generated Resistance) - A byproduct of lift, generated at the wingtips. - Stronger at lower speeds and during takeoff/landing. - Minimized using winglets to control air circulation at the tips. - Wave Drag (At High Speeds) - Significant at transonic and supersonic speeds. - Caused by shockwaves forming around the aircraft. - Reduced using swept-back wings and streamlined designs. - **Factors Affecting Drag & Methods of Reduction (5 minutes)** - Aircraft Shape & Streamlining: - Sleek designs reduce form drag. - Smooth surfaces lower skin friction drag. - Speed & Airflow: - Higher speed increases parasite drag but reduces induced drag. - Supersonic aircraft use specialized designs to control wave drag. - Wing Design & Winglets: - Winglets reduce vortex formation and decrease induced drag. - High-aspect ratio wings (longer, narrower) generate less drag. - **Exercise (5 minutes)** Discuss Why do fighter jets have delta wings while commercial planes have longer wings?
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/9sYxyUQulHc 3. Homework Write a short report on drag reduction techniques in commercial aviation.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What are the main types of drag and how do they affect flight? **2.** Why does induced drag decrease with speed while parasite drag increases? **3.** How do winglets help in reducing drag? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 22	Course Name: UAVs and Drone Technology Topic: Principles of flight including thrust	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the concept of thrust and its role in overcoming drag for sustained flight. b. Explain different types of aircraft propulsion systems (jet engines, propellers, rockets). c. Analyze the factors affecting thrust and methods used to optimize it for efficient flight.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Understand the concept of thrust and its role in overcoming drag for sustained flight. - Explain different types of aircraft propulsion systems (jet engines, propellers, rockets). - Analyze the factors affecting thrust and methods used to optimize it for efficient flight. - **Development** (30 minutes) - **Definition of Thrust:** - The forward force produced by an aircraft's propulsion system. - Directly opposes drag to maintain or increase speed. - How Thrust is Generated: - Engines or propellers accelerate air backward, generating a reaction force (Newton's Third Law). - Higher air acceleration results in greater thrust. - **Types of Propulsion Systems** - Propeller Engines (Piston & Turboprop) - Mechanism: Rotating blades push air backward, generating forward motion. - Advantages: Efficient at low to medium speeds (used in general aviation and turboprop aircraft). - Example: Cessna 172, ATR 72. - Jet Engines (Turbojet, Turbofan, Ramjet, Scramjet) - Turbojet: High-speed air intake, compressed, ignited, and

	expelled at high velocity. - Turbofan: Bypass air increases efficiency (used in commercial aircraft). - Ramjet & Scramjet: Operate at supersonic speeds, relying on high-speed airflow for combustion. - Examples: Boeing 747 (turbofan), Concorde (turbojet), SR-71 Blackbird (ramjet). - Rocket Engines - Generate thrust by expelling high-speed exhaust gases. - Work in space where no air is available for combustion. - - **Factors Affecting Thrust (5 minutes)** - Air Density & Altitude: - Lower air density at high altitudes reduces thrust (jet engines are optimized for high-altitude performance). - Engine Efficiency & Design: - High-bypass turbofans provide greater thrust with lower fuel consumption. - Variable nozzle designs optimize thrust at different speeds. - Speed & Airflow: - Ramjets and scramjets require high-speed airflow to function effectively. - Fuel Type & Combustion Efficiency: - Different fuels affect thrust generation and engine efficiency. - **Exercise (5 minutes)** Discuss Why do commercial planes use turbofans while fighter jets use turbojets?
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/yldLbCuEQwo 3. Homework Write a short report on how thrust is optimized for different flight conditions.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** How does a jet engine generate thrust differently from a propeller engine? **2.** Why does thrust decrease at higher altitudes? **3.** How do scramjets differ from traditional jet engines? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 23	Course Name: UAVs and Drone Technology Topic: Drone stabilization	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Describe the principles of drone stabilization and the role of onboard sensors. b. Explain different stabilization mechanisms such as gyroscopes, accelerometers, and GPS. c. Analyze how stabilization improves drone performance in real-world applications.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define drone stabilization as the ability to maintain steady flight and resist external disturbances (e.g., wind, sudden movements). - Explain why stabilization is critical for smooth flight, precise control, and high-quality imaging. - Introduce the key components responsible for drone stability: - Gyroscopes (detect rotation) - Accelerometers (measure linear motion) - GPS & Barometers (assist in position holding) - Electronic Speed Controllers (ESCs) (adjust motor speeds) - **Development** (30 minutes) - **Drone Stabilization Mechanisms** - Inertial Measurement Unit (IMU) – Gyroscopes & Accelerometers - Gyroscopes detect angular motion and prevent unwanted rotations (roll, pitch, yaw). - Accelerometers sense acceleration forces to correct unwanted shifts in position. - Example: How an IMU helps stabilize a drone during sudden wind gusts. - GPS & Barometer-based Stabilization - GPS enables drones to maintain a fixed position and return home automatically. - Barometers measure altitude changes, helping drones hover at a set height.

	- Example: DJI drones use GPS + barometer to hold altitude when hovering. - Electronic Speed Controllers (ESCs) & Motor Control - ESCs adjust the speed of individual motors to maintain balance. - Example: If a drone tilts to the left, the right-side motors increase thrust to correct it. - Optical Flow & Vision-based Stabilization - Drones use downward-facing cameras & LiDAR to maintain stability in GPS-denied environments (indoors, tunnels). - Example: DJI Mavic drones use optical flow sensors to hover in areas without GPS. - **Types of Drone Stabilization** - Manual vs. Autonomous Stabilization - Manual: Pilot constantly adjusts throttle and direction (RC helicopters). - Autonomous: Flight controller manages stability using IMU, GPS, and ESCs. - Gimbal Stabilization for Cameras - 2-axis vs. 3-axis gimbals reduce vibration and ensure smooth video recording. - Example: How gimbals stabilize aerial footage even in high winds. - Environmental Factors Affecting Stabilization - Wind resistance and turbulence handling. - How drones adjust stabilization based on weight distribution (payloads, cameras). - . - **Exercise (5 minutes)** Discuss on how would drones perform without gyroscopes or accelerometers?
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture shttps://youtu.be/jY6bBcMtseY 3. Homework Write a short report on how AI and machine learning are improving drone stabilization.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** How does an IMU contribute to drone stability? **2.** Why do GPS and barometers improve drone stabilization? **3.** What is the difference between 2-axis and 3-axis gimbal

	stabilization? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 24	Course Name: UAVs and Drone Technology Topic: Control Mechanism	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the key control mechanisms used in drones, including manual and autonomous control. b. Explain the role of flight controllers, radio transmitters, and software in drone navigation. c. Analyze how different control systems impact drone performance in various applications.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define **drone control mechanisms** as the systems that enable precise movement and navigation. - Explain the **two main control types**: - **Manual Control** – Pilot-operated via a remote controller. - **Autonomous Control** – Computer-guided using pre-programmed flight paths. - Highlight the importance of stable and responsive control for **safety, efficiency, and mission success**. - **Development** (30 minutes) - **Components of Drone Control Systems** - **Remote Controller & Radio Transmission** - Drones communicate via **radio signals (2.4 GHz or 5.8 GHz)** using transmitters & receivers. - Controllers send commands like throttle, yaw, pitch, and roll. - **Example:** How an RC transmitter controls a drone's direction and altitude. - **Flight Controller (FC)** - The **brain of the drone**, processing pilot inputs and sensor data. - Types of flight controllers: - **Basic FCs** (for manual flying) - **Advanced FCs** (supporting GPS, AI-based navigation) - **Example:** Betaflight FC for racing drones vs. DJI FC for

	autonomous flying. - **Electronic Speed Controllers (ESCs) & Motor Control** - ESCs adjust **motor speed** to ensure smooth and stable flight. - **Example:** If the drone tilts left, the right-side motors increase speed to balance it. - **Software-based Control & Mobile Apps** - Mobile apps (e.g., DJI Fly, QGroundControl) allow touchscreen control & mission planning. - Features like **return-to-home (RTH)**, waypoint navigation, and geofencing. - **Example:** How drones follow a predefined route using GPS waypoints. - **Types of Drone Control Mechanisms** - **Manual Control (Pilot Operated)** - Uses **joystick-based controllers**. - Suitable for FPV drone racing, photography, or manual inspections. - **GPS-based Control (Semi-Autonomous)** - Drones lock onto GPS coordinates to maintain a stable position. - Used in aerial surveys, agriculture, and mapping applications. - **Example:** DJI Phantom drones using GPS stabilization for steady flights. - **Autonomous Control (AI & Pre-programmed Flights)** - AI-powered drones analyze the environment and adjust flight paths dynamically. - **Example:** Delivery drones using AI to avoid obstacles in real-time. - **Challenges in Drone Control** - **Signal Interference & Loss of Control** - RF interference from Wi-Fi networks, other drones, or metal structures. - Solutions: **Frequency hopping, redundant communication links**. - **Battery Life & Power Management** - Limited flight time requires efficient control algorithms. - **Example:** How intelligent power distribution extends drone endurance. - **Weather Conditions & Environmental Effects** - Strong winds, rain, and temperature variations affect control stability. - **Example:** Wind-resistant drones use sensor fusion (gyroscope + accelerometer + barometer) for stability. -

	Exercise (5 minutes) Discuss on what happens if a drone loses GPS signal mid-flight?
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/2BwUMk10WqI 3. Homework Write a short report on the future of autonomous drones in logistics and security.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** How does a flight controller process pilot commands? **2.** Why is GPS-based control more reliable for long-distance flights? **3.** What are the challenges of autonomous drone navigation? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 25	Course Name: UAVs and Drone Technology Topic: Introduction to Flight Modes	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand key drone flight modes and their control logic b. Explain the role of manual, GPS-based, and autonomous modes in drone operations c. Analyse how flight modes impact drone stability and usability
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - □ Define flight mode as the operational configuration that determines how a drone responds to user input or its surroundings. - □ Explain why flight modes are crucial for: - Safety - Stability - Mission-specific performance (e.g., photography, inspection) - **Development** (30 minutes) - **Manual Mode (Rate/Acro Mode)** - Pilot has full control with no GPS or altitude assistance. - Used in FPV racing, skilled manual flight. - Requires constant adjustments by the operator. - **Stabilize Mode** - Auto-levels the drone when sticks are released. - Good for beginners and learning orientation. - **Altitude Hold Mode** - Maintains a constant altitude using barometric sensors. - Pilot still controls horizontal movement. - **GPS/Loiter Mode** - Maintains position using GPS. - Used for stable hovering, ideal for aerial photography. - Automatically counters wind and drift. - **Return-to-Home (RTH) Mode** - Automatically returns to home point when triggered. - Useful during low battery or signal loss. - **Waypoint/Autonomous Mode** - Pre-defined flight paths using GPS coordinates. - Used in mapping, agriculture, and delivery drones.

	- Controlled via mobile apps (e.g., DJI Fly, QGroundControl). - **Exercise (5 minutes)** Group discussion: Which flight mode would you choose for drone delivery in a city and why?
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/2BwUMk10WqI 3. Homework Write a short note comparing manual and GPS-based flight modes for drone photography.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What is the safest flight mode for beginners? **2.** Why is Loiter mode better for aerial photography? **3.** What challenges could occur in GPS mode? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 26	Course Name: UAVs and Drone Technology Topic: Introduction to Drone Maneuvers	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand basic aerial maneuvers performed by drones b. Explain how roll, pitch, yaw, and throttle affect drone motion c. Analyze how different maneuvers are used in real-world applications
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define **drone maneuvers** as the controlled movements along different axes. - Briefly describe the four basic controls: o **Roll** – Tilts left/right o **Pitch** – Tilts forward/backward o **Yaw** – Rotates left/right o **Throttle** – Controls altitude - **Development** (30 minutes) - **Roll** - Moves drone sideways. - Used in turning or dodging obstacles in tight spaces. - *Example:* Avoiding an object during inspection. - **Pitch** - Tilts drone forward/backward. - Used to move forward or backward. - *Example:* Drone tracking a moving car from behind. - **Yaw** - Rotates drone clockwise or counter-clockwise. - Useful for panoramic photography and reorienting direction. - **Throttle** - Increases or decreases altitude. - *Example:* Climbing to inspect a rooftop or descending to land. - **Combining Maneuvers** - Advanced movements combine roll + pitch + yaw. - *Example:* Orbiting around a subject in a cinematic shot). - **Exercise (5 minutes)** Ask students to Recap all four basic movements and real-world

	use.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/sXkyE0aObXk 3. Homework Draw a labeled diagram of a drone and indicate directions for pitch, yaw, roll, and throttle. Briefly describe when each is used.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** Which movement is used to climb vertically? **2.** How do you turn a drone while it's flying forward? **3.** Why is it important to combine yaw and pitch in aerial videography? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 27	Course Name: UAVs and Drone Technology Topic: Global Positioning System (GPS)	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the basic concept and working principle of GPS b. Identify key components of the GPS system (space, control, and user segments) c. Analyze the role of GPS in drone navigation and other real-world applications.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define GPS (Global Positioning System): A satellite-based navigation system providing geolocation and time information to a GPS receiver anywhere on Earth. - Importance of GPS: - Used in mobile phones, cars, aircraft, and drones. - Critical for real-time location tracking, mapping, and autonomous navigation. - **Development** (30 minutes) - **Components of GPS** - Space Segment - Consists of a constellation of ~30 satellites orbiting Earth. - Continuously transmit signals containing time and orbital data. - Control Segment - Ground-based stations monitor and control satellites. - Correct satellite positions and synchronize atomic clocks. - User Segment - Includes GPS receivers in phones, cars, drones, etc. - Receives signals from at least four satellites to calculate position. **Working Principle of GPS** - Triangulation using at least 4 satellites. - Each satellite transmits time-stamped signals. - GPS receiver calculates distance based on signal travel time. - Determines precise location (latitude, longitude, and altitude). - **Accuracy and Error Sources** - Common sources of errors:

	- Atmospheric delays (ionosphere, troposphere) - Multipath interference (signals bouncing off buildings) - Satellite geometry and clock errors - Accuracy improved using: - Differential GPS (DGPS) - Real-Time Kinematic (RTK) GPS - **Applications of GPS** - In Drones: Autonomous navigation, return-to-home, geofencing, waypoint missions. - In Transportation: Fleet tracking, route optimization. - In Agriculture: Precision farming, crop monitoring. - In Surveying: Land mapping, construction planning. - **Exercise (5 minutes)** **Think-Pair-Share Activity** Q: What could happen to a drone mid-flight if it loses GPS signal? Students discuss with a partner and share responses with the class.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture 3. https://youtu.be/4l2yvvI_cgk 4. Homework Write a short report (150 words) on how GPS improves drone delivery systems. Include potential limitations or challenges.s
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What are the three main segments of the GPS system? **2.** How does a GPS receiver calculate its position? **3.** Why is GPS critical for drone stability and mission accuracy. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 28	Course Name: UAVs and Drone Technology Topic: GPS Role In Drone Navigation	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand how GPS is integrated into drone systems for real-time navigation. b. Explain various GPS-enabled features used in modern drones. c. Analyze the significance of GPS in enhancing drone safety, automation, and performance.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Begin with a question: "Have you ever seen a drone return to the take-off point on its own?" - Introduce Global Positioning System (GPS) as a satellite-based navigation system. - Highlight its critical role in drone operations: accurate flight paths, automated missions, and safety protocols. - - **Development** (30 minutes) - **1. How GPS Works in Drones** - GPS provides **real-time location data** (latitude, longitude, altitude). - Drones receive signals from **at least 4 satellites** to determine their position using triangulation. - **2. GPS-Enabled Features in Drone Navigation** - **Waypoint Navigation** → Drones follow pre-set coordinates autonomously. → Used in agriculture, surveying, aerial inspections. - **Return-to-Home (RTH)** → Drone automatically returns to the take-off point if signal is lost or battery is low. - **Hovering & Position Hold** → GPS allows drones to maintain **stable position and altitude**, even in wind. → Important for photography, surveying, and precise landings. - **Geofencing** → Virtual boundaries restrict drones from entering no-fly zones. → Enhances compliance with regulations. - **3. Importance of GPS in Drone Performance** - **Safety**: Prevents loss of drones, enables controlled flight.

	- **Autonomy**: Allows drones to fly without manual input. - **Accuracy**: Crucial for mapping, delivery, and rescue operations. - **4. Challenges in GPS Use** - **Signal Loss**: Buildings, trees, or interference can block GPS signals. - **Environmental Factors**: Clouds, rain, or magnetic interference affect precision. - **Latency**: GPS signals may have minor delays affecting real-time decisi - **Exercise (5 minutes)** **Group Discussion:** Q: If a drone loses GPS signal mid-flight, what problems could arise? How can these be addressed?
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/TQbdyP2g-KI 3. Homework Write a short report (150 words) how GPS-enabled drones are transforming delivery and surveillance systems.”
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What role does GPS play in the Return-to-Home function? **2.** Why is GPS essential for waypoint-based missions? **3.** What are the risks of GPS failure during a drone flight? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 29	Course Name: UAVs and Drone Technology Topic: **Autonomous flight and obstacle avoidance systems**	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand how autonomous flight systems operate in drones. b. Explain the technologies used for real-time obstacle detection and avoidance. c. Analyze how autonomy and obstacle avoidance improve flight safety and functionality.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Begin with a question: How do drones fly through forests or buildings without crashing? - Introduce the concept of Autonomous Flight: → Flight without continuous human control. - Mention the importance of Obstacle Avoidance Systems for safe navigation, especially in dynamic or complex environments. - - **Development** (30 minutes) - **1. What is Autonomous Flight?** - Drone uses sensors, GPS, and onboard processors to fly with minimal or no human intervention. - Often involves mission planning, waypoint navigation, and decision-making in real time. - **2. Key Components of Autonomous Flight Systems** - Flight Controller: The brain of the drone that processes data. - GPS Module: Guides drone to specified coordinates. - IMU (Inertial Measurement Unit): Tracks motion and orientation. - Barometer/Altimeter: Measures altitude. - Camera/Vision Sensors: Used for visual navigation and target recognition. - **3. Obstacle Avoidance Systems** - Ultrasonic Sensors: Emit sound waves to detect nearby objects. - Infrared Sensors: Detect distance using IR reflection. - LiDAR (Light Detection and Ranging): High-accuracy 3D mapping. - Stereo Cameras: Depth perception using dual cameras.

	- AI/ML Algorithms: Real-time decision-making to change direction or stop. - **4. Working Principle of Obstacle Avoidance** - Sensors detect objects within a threshold distance. - Onboard processor calculates avoidance path or triggers braking. - Integration with flight control ensures smooth rerouting. - **5. Applications of Autonomous and Obstacle-Avoiding Drones** - Delivery Services: Drones navigating cities, avoiding buildings. - Surveillance: Navigating indoors or around structures. - Agriculture: Autonomous spraying and terrain following. - Disaster Response: Entering dangerous or unknown areas. - **6. Limitations and Challenges** - Sensor limitations in fog, rain, low light. - Computational delay in decision-making. - Cost of high-end avoidance systems (e.g., LiDAR). - Need for regulatory frameworks for fully autonomous drones. - **Exercise (5 minutes)** **Quick Think-Pair-Share** If a drone is flying through a forest and suddenly detects a tree, what should it do?
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/gMcA0ZxOl5Q 3. Homework Write a 150-word summary on how autonomous drones improve rescue operations in disaster-hit areas using obstacle avoidance.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What is the role of AI in obstacle avoidance? **2.** Why are multiple sensors used instead of just one? **3.** Who benefits most from fully autonomous drones in real-world use? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 30	Course Name: UAVs and Drone Technology Topic: Sensor technologies for mapping	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the role of various sensors used in drone-based mapping. b. Describe and compare key sensor technologies like LiDAR, RGB, multispectral, and thermal sensors. c. Analyze how sensor selection impacts mapping accuracy and application suitability.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Ask question: How do drones create detailed 3D maps of terrain or structures from the air?" - Introduce the concept: Drones use onboard sensors to gather data (visual, depth, thermal) for creating maps. - Highlight that sensor choice determines the type, accuracy, and quality of mapping. - - **Development** (30 minutes) - **1. Role of Sensors in Mapping** - Drones use sensors to collect environmental data which is processed into 2D/3D maps. The choice of sensor affects the type and accuracy of the mapping. - **2. Key Sensor Types and Applications** - **RGB Cameras** Capture standard color images. → Used in general mapping, construction monitoring. - **LiDAR (Light Detection and Ranging)** Uses laser pulses to measure distances precisely. → Ideal for 3D terrain mapping, forestry, and mining. - **Multispectral Sensors** Capture light beyond visible spectrum (e.g., NIR). → Useful in agriculture for monitoring crop health. - **Thermal Sensors** Detect temperature differences. → Used in search and rescue, power line inspection. - **3. Factors Influencing Sensor Choice**

	- Desired accuracy - Terrain/environment type - Weather and lighting conditions - Mission objectives and budget - **4. Benefits of Sensor-Based Mapping** - Faster data collection - High-resolution, real-time results - Suitable for hard-to-reach areas - Supports AI-based analysis - **Exercise (5 minutes)** **Scenario-Based Quick Activity** You are planning to map a dense forest area to analyze tree height and terrain structure. Which sensor would you choose and why? • Allow students 1–2 minutes to think • Take 2–3 quick responses from volunteers • Encourage reasoning based on sensor characteristics
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/XHnJKZ8bFfk 3. Homework Write a short report (150–200 words) on how multispectral sensors are used in smart farming applications. Include at least two benefits of using drone-based sensors over traditional methods.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What is the advantage of using LiDAR over an RGB camera for mapping uneven terrain? **2.** Why are multispectral sensors important in agriculture? **3.** Who benefits the most from thermal mapping using drones? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 31	Course Name: UAVs and Drone Technology Topic: Sensor technologies for mapping	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand different types of imaging sensors used in drones. b. Explain the working principles of imaging sensors such as RGB, multispectral, thermal, and hyperspectral. c. Evaluate the suitability of various sensors for specific imaging applications.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Ask question: How can drones see things that our eyes cannot?" - Introduce the concept of imaging sensors as devices that detect and convert light or radiation into usable images. - Highlight how different imaging sensors serve different real-world purposes—some visible, some invisible. - **Development** (30 minutes) - 1. Overview of Imaging Sensors - Imaging sensors in drones are used to capture data as images for various applications such as inspection, agriculture, surveillance, and research. - 2. Major Sensor Types and Their Use - RGB Sensors - Capture images in red, green, and blue bands (standard color images). - → Used in general photography, surveying, construction monitoring. - Multispectral Sensors - Capture specific wavelength bands (e.g., visible + near-infrared). - → Used in crop health monitoring, soil mapping, water quality analysis. - Thermal Infrared Sensors - Measure heat radiation instead of light. - → Ideal for firefighting, search and rescue, insulation inspection.

	- Hyperspectral Sensors - Capture hundreds of narrow spectral bands. - → Used for detailed mineral analysis, environmental monitoring. - 3. Key Sensor Features to Consider - Resolution: Clarity of image. - Spectral Range: Which parts of light/radiation it can detect. - Frame Rate: How fast it captures data. - Weight and Power Consumption: Affects drone endurance. - 4. Advantages of Sensor-Based Imaging - Provides visual and non-visual data. - Enables decision-making in real time. - Useful in inaccessible or dangerous areas. - Enhances accuracy in applications like agriculture, law enforcement, and maintenance. - **Exercise (5 minutes)** • Ask students to summarize the lecture
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture **https://youtu.be/XHnJKZ8bFfk** 3. Homework Write a short report (150–200 words) explaining the differences between thermal and multispectral imaging. Mention one use case for each.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What makes thermal sensors different from RGB cameras? **2.** Why are multispectral sensors preferred in precision agriculture? **3.** Who would benefit most from hyperspectral imaging? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 32	Course Name: UAVs and Drone Technology Topic: Sensor technologies for data collection	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the role of sensors in drone-based data collection. b. Identify different types of sensors used for collecting various types of data. c. Analyze how sensor data enhances decision-making in real-world applications.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Introduce the concept of data collection via sensors, where sensors act as the eyes, ears, and skin of drones. - Emphasize the importance of collecting real-time, accurate data for analysis and action in sectors like agriculture, disaster response, and urban planning. - - **Development** (30 minutes) - **1. What is Data Collection in Drones?** - Sensors are onboard instruments that gather information from the environment such as images, distances, temperatures, gases, etc. → This data is used for mapping, monitoring, or decision-making. - - **2. Types of Sensors for Data Collection** - **Imaging Sensors (RGB, Multispectral, Thermal)** → Collect visual and spectral data for mapping, monitoring plant health, and identifying heat sources. - **LiDAR (Light Detection and Ranging)** → Measures distance using lasers to create high-accuracy 3D maps and elevation models. - **Ultrasonic and Infrared Sensors** → Used for proximity sensing and obstacle detection, often contributing to safe navigation. - **Gas Sensors** → Detect gases such as CO_2, methane, or pollutants; useful in environmental monitoring and industrial safety. - **Weather Sensors** → Collect wind speed, temperature, humidity, pressure; used

	for meteorological data collection. - **GNSS (Global Navigation Satellite System) Receivers** → Provide geolocation data, ensuring all collected data is georeferenced accurately. - - **3. Factors Affecting Sensor Data Accuracy** - Altitude and speed of the drone - Environmental conditions (e.g., wind, fog, rain) - Calibration and quality of sensors - Data synchronization and storage capabilities - - **4. Applications of Sensor-Based Data Collection** - **Precision Agriculture** – Crop stress detection, soil analysis - **Disaster Management** – Damage assessment, thermal imaging in rescue - **Urban Planning** – Land use mapping, construction monitoring - **Environmental Monitoring** – Air quality, forest health, water contamination - **Exercise (5 minutes)** • Quick Pair Discussion In pairs, students discuss the following: Which sensor would be ideal for detecting water pollution in a lake using a drone, and why?
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture **https://youtu.be/Vp-V-pgK-vA** 3. Homework Write a short report (150–200 words) on how sensor-based data collection is helping one of the following areas: agriculture, urban development, or environmental conservation.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What types of data can a multispectral sensor collect? **2.** Why is LiDAR preferred over cameras in terrain mapping? **3.** Who benefits the most from real-time sensor data—give one example. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 33	Course Name: UAVs and Drone Technology Topic: Drone Operation	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the basic components and controls of a drone. b. Explain pre-flight, in-flight, and post-flight procedures. c. Demonstrate safe and responsible drone operation practices.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - What do you think are the key steps to fly a drone safely?" - Briefly explain that drone operation involves technical knowledge, planning, and safety awareness. - Emphasize its importance in modern applications: surveying, delivery, photography, disaster response, etc. - - **Development** (30 minutes) - **1. Basic Components of a Drone** - **Frame** – structure of the drone - **Propellers and Motors** – generate lift - **Flight Controller** – brain of the drone - **GPS Module** – location tracking and navigation - **Battery & Power System** – powers the drone - **Camera (optional)** – used for imaging or video - **2. Drone Control Interface** - **Transmitter/Remote Controller** – sends signals - **Mobile App or FPV Screen** – live video feed and telemetry - **Control Sticks** – manage altitude, direction, rotation - **3. Steps in Drone Operation** - **Pre-flight Checklist** → Battery charged → Propellers intact → GPS signal locked → Environment clear for take-off → Weather conditions checked - **In-flight Operation** → Take-off slowly and stabilize → Maintain visual line of sight → Monitor battery and GPS → Avoid no-fly zones and obstacles

	- **Post-flight Tasks** → Land smoothly → Power off drone and controller → Inspect for any damage → Transfer and store data - **4. Safety Guidelines** - Maintain minimum altitude as per local regulations - Avoid crowded or restricted areas - Follow DGCA/local aviation authority rules - Use return-to-home feature in emergencies - **Exercise (5 minutes)** Help students memorize and apply the key steps in a Pre-Start Inspection and Safety (PSIS) check for drones
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture **https://youtu.be/qb3j7qgGvK4** 3. Homework Write a short report (150–200 words) on the importance of pre-flight checks and how it contributes to drone safety.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What happens if a drone loses GPS signal mid-flight? **2.** Why is it important to keep visual line of sight during operation? **3.** Who is responsible if a drone causes damage—pilot or manufacturer? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 34	Course Name: UAVs and Drone Technology Topic: Flight Planning	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the importance of flight planning in drone operations. b. Identify the key components of a flight plan. c. Analyze safety, legal, and environmental considerations in drone flight planning.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Begin with a real-world example of a failed or successful drone mission due to flight planning. - Ask: "What could go wrong if a drone is launched without proper planning?" - - **Development** (30 minutes) - **a. What is Flight Planning?** - The process of organizing all steps necessary before a drone flight. - Ensures efficiency, safety, and legal compliance. - **b. Key Components of a Flight Plan:** - **Mission Objective** – e.g., mapping, inspection, delivery. - **Location Mapping** – Identify takeoff/landing sites, obstacles, terrain. - **Altitude & Distance Parameters** – Max height, area coverage. - **Weather Check** – Wind, rain, GPS signal strength. - **Airspace Check** – Avoid no-fly zones, manned aircraft paths. - **Battery & Equipment Status** – Ensure sufficient charge and backup. - **Emergency Procedures** – Define Return-to-Home path, landing zones. - **Permissions/Regulations** – Local UAV laws, flight authorizations. - **c. Tools Used in Flight Planning:** - Mapping software (e.g., Google Earth, Litchi, DJI GS Pro) - Weather apps (e.g., UAV Forecast) - Airspace maps (e.g., Airmap, Skyward) - **d. Importance of Flight Planning:** - Ensures safe, legal, and efficient operations. - Reduces risk of drone loss or crash. - Supports data accuracy in imaging/mapping missions.

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	Exercise (5 minutes)
	Plan Your Mission!
	• Students are given a sample mission: *Survey a farmland area for crop health.*
	• In pairs, they answer:
	  ○ What will be the takeoff/landing spot?
	  ○ What time and weather conditions are ideal?
	  ○ What is the max altitude and flight path?
	  ○ What should be the emergency plan?

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/NdGeua_fP7U 3. Homework Write a short report (150–200 words) on the importance of pre-flight checks and how it contributes to drone safety.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What is the most important part of a flight plan, and why? **2.** What could go wrong if emergency procedures are missing? **3.** Who should be involved in planning a professional drone flight? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 35	Course Name: UAVs and Drone Technology Topic: Practical Implementation of application-based Drone Model.	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the workflow of deploying a drone for a real-world task. b. Identify key components required for building and programming an application-specific drone. c. Implement a basic operational demonstration of a drone model for a selected application. d. Evaluate the effectiveness and challenges of the implemented drone model.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Begin with a quick video showing drones used in agriculture, delivery, or surveillance. - Ask students: - Have you ever seen a drone being used for a real task? What was it doing? - - **Development** (30 minutes) - a. Understanding Application-Based Drone Models - Discuss how drones are designed with specific applications in mind: - Agriculture: crop monitoring, spraying - Surveillance: area monitoring, security - Delivery: logistics, medicine transport - Disaster Management: thermal imaging, search & rescue - Mapping & Surveying: terrain analysis - b. Steps for Practical Implementation - Define Application - Choose one: e.g., “Agricultural crop health monitoring.” - Drone Selection/Customization - Sensors (e.g., multispectral camera), GPS, flight controller - Software Configuration - Pre-program mission using tools like DroneDeploy, Pix4D, or DJI GS Pro - Safety & Pre-Flight Checks - Battery check, weather check, geofencing - Mission Execution

	- Fly the route; gather data - Post-Mission Analysis - Download data, interpret results - c. Demonstration - Show a real drone or simulation model performing a simple task (e.g., route flying, image capture). - Explain each stage from planning to execution. - **Exercise (5 minutes)** **Plan Your Mission!** o Ask students to attempt an online quiz on Nearpod
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/NdGeua_fP7U 3. Homework Find a news article or journal report on drone use in real applications (e.g., COVID supply drops, smart farming). Write a 150-word analysis of its implementation, benefits, and challenges.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What makes a drone effective in a specific application? **2.** Why is safety planning essential before implementing a real-world drone mission? **3.** What are some limitations you foresee in your planned model? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 36	Course Name: UAVs and Drone Technology Topic: Flight Control Algorithms	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the purpose of flight control algorithms in drones. b. Explain the role of sensors and feedback in maintaining stability. c. Describe common control algorithms (PID, GPS-based, etc.). d. Analyze how algorithms enhance drone precision and autonomy.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define flight control algorithms as the core programs that govern drone behavior during flight. - Emphasize the difference between manual and algorithm-based control. - Highlight why control algorithms are crucial for flight stability, trajectory correction, and autonomy. - - **Development** (30 minutes) - **1. Components of Drone Control Systems** - **Remote Controller & Radio Transmission** - Operates via RF signals (2.4 GHz / 5.8 GHz) to send commands like throttle, yaw, pitch, and roll. - Example: A drone responding to joystick input during takeoff. - **Flight Controller (FC)** - Central unit that processes input from both the user and sensors. - Executes control logic (e.g., PID, fuzzy logic) to adjust drone behavior. - Example: DJI NAZA vs. Betaflight. - **Electronic Speed Controllers (ESCs)** - Receive PWM signals from the flight controller to regulate motor speeds. - Example: Adjusting opposite motors for pitch/roll corrections. - **IMU and Sensors (Gyroscope, Accelerometer, Magnetometer, Barometer)** - Measure drone orientation, movement, altitude, and heading. - Data fused by the flight controller for accurate positioning. - **2. Types of Flight Control Algorithms**

	- **PID Control (Proportional, Integral, Derivative)** - Most common control algorithm for maintaining flight stability. - Explains how PID adjusts motor speed to maintain balance. - Visual example: Line-following or level flight simulation using PID. - **GPS-Based Control** - Used for position hold, waypoint navigation, and return-to-home (RTH). - GPS feeds coordinate data to the controller for guided navigation. - **Sensor Fusion & AI-based Control** - Combines input from multiple sensors to make decisions. - Used in terrain-following, object detection, and automated route planning. - Example: Obstacle avoidance using vision sensors with AI inference. - - **3. Applications and Challenges** - **Applications** - Agriculture: Precision spraying using GPS and path-planning algorithms. - Logistics: Autonomous delivery drones maintaining route stability. - Surveillance: Stable hovering and path tracking over long distances. - **Challenges** - Signal Interference: Loss of control due to noisy environments. - Environmental Effects: Wind and temperature fluctuations disrupting flight. - Battery Constraints: Algorithms managing flight path to optimize energy usage. **Exercise (5 minutes)** **Plan Your Mission!** Ask students to simulate PID behavior using a basic analogy: You are balancing a stick vertically on your palm. If it tilts, how do you respond?
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/2BwUMk10WqI 3. Homework Write a short report (150–200 words): How flight control algorithms enable drones to perform complex tasks in urban environments.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and

	discuss. **1.** What role does a PID algorithm play in a drone's stability? **2.** Why is sensor fusion important in autonomous drones? **3.** Who is responsible for adjusting motor outputs during wind disturbances? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 37	Course Name: UAVs and Drone Technology Topic: Flight Control Algorithms	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the fundamental navigation algorithms used in drones for path planning and obstacle avoidance. b. Explain how GPS, sensor data, and algorithms combine to guide drones autonomously. c. Analyze how navigation algorithms affect drone efficiency, accuracy, and safety in various applications.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define navigation algorithms as computational methods that determine the drone's path from start to destination. - Explain why navigation is critical for autonomous flight, obstacle avoidance, and mission success. - Briefly introduce common algorithms (GPS waypoints, graph-based pathfinding, SLAM). - - **Development** (30 minutes) - 1. Key Elements of Navigation Algorithms - GPS-based Path Planning - Using GPS coordinates and waypoints to define flight routes. - Example: Drone flying from point A to B using predefined GPS points. - Obstacle Detection and Avoidance - Algorithms use sensor data (LiDAR, ultrasonic, vision) to detect obstacles. - Path recalculation to avoid collisions dynamically. - Simultaneous Localization and Mapping (SLAM) - Real-time mapping of unknown environments while tracking drone location. - Example: Indoor drone navigation where GPS is unavailable. - 2. Common Navigation Algorithms - *A Algorithm** - Graph-based shortest path algorithm widely used in robotics. - Finds the optimal route by evaluating possible paths.

	- Dijkstra's Algorithm - Calculates shortest path on weighted graphs; less heuristic-driven than A*. - Used in static or known environments. - Potential Field Method - Treats obstacles as repulsive forces and targets as attractive forces. - Drone navigates by balancing these virtual forces to avoid collisions. - 3. Integration with Drone Systems - Combining GPS data with sensor input for real-time corrections. - Flight controller executes navigation commands based on algorithm outputs. - Software platforms allow users to set mission parameters (waypoints, no-fly zones). - - 4. Applications and Challenges - Applications - Surveying and mapping with precise waypoint navigation. - Delivery drones following dynamic routes with obstacle avoidance. - Search and rescue in GPS-denied environments using SLAM. - Challenges - Algorithm complexity vs. computational power limits. - Environmental factors causing sensor noise or GPS inaccuracies. - Real-time processing and quick decision-making under uncertain conditions. - - **Exercise (5 minutes)** **Group Discussion:** Imagine a drone must deliver a package through a cluttered urban area. What navigation challenges could arise and how would navigation algorithms help overcome them
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/14sD7M1nKtk 3. Homework Write a short report (150–200 words): Explain how SLAM navigation benefits drones operating indoors or in GPS-denied environments.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss.

	1. What role does a PID algorithm play in a drone's stability? **2.** Why is sensor fusion important in autonomous drones? **3.** Who is responsible for adjusting motor outputs during wind disturbances? Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 38	Course Name: UAVs and Drone Technology Topic: Flight Control Algorithms	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the concept of path planning algorithms used in drones for efficient navigation. b. Explain different types of path planning algorithms and their applications. c. Analyze how path planning improves drone performance in obstacle avoidance and mission efficiency.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define path planning as the process of determining an optimal route for a drone to reach its destination while avoiding obstacles. - Emphasize the importance of path planning for autonomous navigation and mission success. - Briefly introduce types of path planning: global and local. - **Development** (30 minutes) - **1. Basics of Path Planning Algorithms** - Algorithms compute paths based on environmental data and mission goals. - Key objectives: minimize distance, avoid obstacles, optimize flight time and energy consumption. - - **2. Types of Path Planning Algorithms** - *Grid-based Algorithms (e.g., A Algorithm)** - Represent environment as a grid; find the shortest path using heuristics. - Widely used in obstacle-rich environments. - **Sampling-based Algorithms (e.g., Rapidly-exploring Random Tree - RRT)** - Explore random points in space to build a feasible path incrementally. - Useful in complex and dynamic environments. - **Potential Field Algorithms** - Treat obstacles as repulsive forces and goals as attractive forces to generate smooth paths.

	- Simple but can get stuck in local minima. - **Dijkstra's Algorithm** - Finds the shortest path in weighted graphs without heuristics. - Useful when all path costs must be considered. - - **3. Applications of Path Planning in Drones** - Autonomous delivery ensuring safe and efficient routes. - Surveying and mapping areas with obstacle avoidance. - Search and rescue missions requiring dynamic re-routing. - - **4. Challenges in Path Planning** - Real-time computation with limited onboard resources. - Dynamic obstacles and environmental changes. - Balancing between shortest path and safest path. - - **Exercise (5 minutes)** **Group Activity:** Given a simple map with obstacles, students sketch or discuss a possible drone path using either grid-based or potential field logic. Discuss which algorithm might work best and why.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/tx8-MbE8jkA 3. Homework 4. Write a short report (150 words) on how path planning algorithms enhance autonomous drone navigation in urban environments.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What is the main goal of path planning algorithms in drone navigation? **2.** Why might a sampling-based algorithm be preferred in complex environments? **3.** What are some limitations or challenges when implementing path planning algorithms in real-time drone flights? Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 39	Course Name: UAVs and Drone Technology Topic: Obstacle Detection and Avoidance	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the significance of obstacle detection and avoidance in drone operations. b. Explain various sensors and technologies used for detecting and avoiding obstacles. c. Analyze how real-time data is used to ensure safe drone navigation in dynamic environments.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Define obstacle detection and avoidance as the capability of drones to perceive and avoid objects in their flight path. - Highlight its critical role in autonomous drone navigation**,** collision prevention**,** and safe operations in GPS-denied or cluttered environments. - **Development** (30 minutes) - 1. Sensors for Obstacle Detection - Ultrasonic Sensors: Emit sound waves to detect nearby objects. - Best for short-range, indoor environments. - Infrared (IR) Sensors: Detect heat or reflectance of infrared beams. - Suitable for basic proximity sensing. - LIDAR (Light Detection and Ranging): Measures distance using laser light. - High accuracy, useful for mapping and 3D perception. - Stereo Cameras / Optical Flow Sensors: Capture visual depth to detect motion and distance. - Used in image-based navigation. - Radar: Penetrates fog, rain, or dust; used in industrial-grade drones. - Example: Used in autonomous flying taxis and delivery drones. - - 2. Obstacle Avoidance Algorithms - Reactive Algorithms: Immediate response to detected obstacles without planning.

	- Fast, used in basic avoidance. - Deliberative Algorithms: Plan a path considering known obstacles. - Used in mission-driven drones. - Sensor Fusion: Combines inputs from multiple sensors (e.g., camera + LIDAR) for better reliability and accuracy. - - 3. Real-world Applications - Delivery drones avoiding buildings, power lines. - Agricultural drones detecting trees and terrain variation. - Surveillance drones maintaining distance from people or structures. - - 4. Challenges and Solutions - False Positives/Negatives: Misidentification of objects. - Solution: Calibrate sensors, use redundancy. - Environmental Interference: Fog, dust can reduce sensor accuracy. - Solution: Use radar or fusion techniques. - Processing Delays: Lag in decision-making. - Solution: Optimize onboard software. - - **Exercise (5 minutes)** **Short Group Activity:** • Show students a drone flight simulation or video. • Ask them to identify how the drone detects and avoids an obstacle. • Groups write one key observation and suggest which sensor might have been use
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/n7kT50QrXvY 3. Homework 4. Write a short report (150 words) on how obstacle detection and avoidance are essential in drone delivery systems in urban areas..
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What types of sensors are best suited for outdoor long-range obstacle detection? **2.** Why is sensor fusion important in obstacle avoidance? **3.** What are some limitations of using vision-based systems in low-light conditions? Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 40	Course Name: UAVs and Drone Technology Topic: Target Tracking Algorithms	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the basic principles of target tracking in drone applications. b. Explain different types of tracking algorithms used in drones. c. Analyze how real-time data from sensors is used to follow and predict the motion of moving targets.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Introduce target tracking as the capability of a drone to follow a moving object or person automatically. - Mention common uses: surveillance, delivery, wildlife monitoring, event filming. - Briefly explain the need for precision, adaptability, and low-latency computation. - **Development** (30 minutes) **1. Types of Target Tracking Algorithms** • **Color/Object-Based Tracking** o Drones identify and follow a specific color or shape. o Simple but limited in changing environments. o Example: A drone following a red car. • **Optical Flow** o Measures how pixels in the camera image move between frames. o Good for estimating movement direction and speed. o Used in dynamic scenes and low-speed tracking. • **Correlation Filters (e.g., KCF - Kernelized Correlation Filter)** o Track an object using a bounding box and continuously update it. o Fast and used in real-time video-based tracking. • **Kalman Filter** o Predicts the next position of a moving object using current velocity and past positions. o Useful in reducing sensor noise and tracking with GPS data. • **Particle Filter**

	○ Tracks objects with high uncertainty by estimating multiple possible positions. ○ Better than Kalman in non-linear or non-Gaussian scenarios. • **Deep Learning-Based Tracking (e.g., YOLO, DeepSORT)** ○ Uses neural networks for detecting and re-identifying objects across frames. ○ Highly accurate and adaptive; used in intelligent surveillance drones. **2. Real-World Applications** • Security drones tracking intruders in a restricted area. • Filming drones following athletes or wildlife. • Delivery drones locating and tracking customers. **3. Challenges in Target Tracking** • **Occlusion**: When the target disappears behind an obstacle. ○ Solution: Predictive algorithms like Kalman filter. • **Lighting and Weather Variations**: Affect camera input. ○ Solution: Sensor fusion or thermal imaging. • **Multiple Targets**: Confusion due to similar objects. ○ Solution: Deep learning and identity matching algorithms. - **Exercise (5 minutes)** Ask Students to summarize the lecture
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/LiSx4GZ6WdM 3. Homework Write a short report (150 words) on Compare Kalman Filter and Optical Flow for target tracking in drones.
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What are the limitations of using color-based tracking in real-world environments? **2.** Why is the Kalman filter widely used in drone navigation and tracking? **3.** How can deep learning improve accuracy in dynamic tracking scenarios? Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 41	Course Name: UAVs and Drone Technology Topic: Swarm Algorithms	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the concept of swarm intelligence and its application in drone operations. b. Explain different swarm algorithms like Particle Swarm Optimization and Ant Colony Optimization. c. Analyze how drone swarms coordinate autonomously in real-world missions using decentralized control.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - Begin with a question: "Have you seen a group of drones fly together like a flock of birds?" - Define Swarm Algorithms as computational models inspired by the behavior of social insects or animals (e.g., birds, ants, fish) used to coordinate multiple autonomous drones. - Mention applications: military surveillance, agriculture, disaster management, light shows. - - **Development** (30 minutes) **1. Key Features of Swarm Algorithms** • **Decentralized Control**: No central leader, each drone makes local decisions. • **Simple Rules**: Each agent follows basic rules based on neighbors. • **Self-Organization**: The group behaves in an organized manner without external direction. • **Scalability**: Works efficiently even as more drones are added. **2. Common Swarm Algorithms** • **Particle Swarm Optimization (PSO)** o Each drone (particle) searches for an optimal position by learning from its own experience and neighbors. o Application: Area mapping, environmental monitoring. • **Ant Colony Optimization (ACO)** o Simulates how ants find the shortest path by leaving pheromone trails. o Application: Route optimization for delivery drones or obstacle-rich environments. • **Boids Algorithm (Flocking Behavior)**

	○ Models bird flocks using three rules: separation, alignment, cohesion. ○ Used in formation flying and drone light shows. • **Bee Algorithm** ○ Mimics the foraging behavior of bees to search large areas. ○ Used in disaster search & rescue missions. **3. Real-World Applications** • **Search & Rescue**: Swarms cover large areas more efficiently. • **Military Surveillance**: Coordinated drones avoid radar detection and monitor large zones. • **Light Shows**: Hundreds of drones use swarm principles for synchronized performances. • **Agricultural Monitoring**: Multiple drones coordinate to scan large crop fields quickly. **4. Challenges in Swarm Operations** • **Communication Delays**: Drones must share information in real time. • **Collision Avoidance**: Maintaining safe distances automatically. • **Energy Management**: Efficient power use when performing distributed tasks. • **Environmental Interference**: Wind, signal jamming, and obstacles affect performance. - **Exercise (5 minutes)** Ask Students to summarize the lecture
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/_sUeGC-8dyk 3. Homework Write a short report (150 words) on how can swarm intelligence improve efficiency in agricultural drone operations?
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** What is the key difference between centralized and decentralized control in drones? **2.** Why are simple rules effective in swarm-based systems? **3.** What makes the Boids algorithm suitable for drone formations? Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 42	Course Name: UAVs and Drone Technology Topic: Image Processing	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the basic concepts of image processing used in drones. b. Explain the steps involved in image acquisition, preprocessing, feature extraction, and classification. c. Analyze how image processing helps in real-time drone applications like surveillance, mapping, and target tracking.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - How do drones recognize landmarks, people, or objects while flying? - Define Image Processing as the method of performing operations on images to enhance them or extract useful information. - Relevance to drones: Enables tasks like obstacle detection, navigation, inspection, and mapping. - **Development** (30 minutes) **1. Image Acquisition** • Capturing images using drone-mounted cameras (RGB, infrared, thermal). • Example: A drone flying over a field captures crop health using NDVI imaging. **2. Preprocessing** • Enhancing image quality: Noise reduction, contrast adjustment, and sharpening. • Example: Removing blurriness from a live drone feed during flight in foggy conditions. **3. Feature Extraction** • Detecting key features like edges, corners, shapes, and motion. • Techniques: Edge Detection (Sobel, Canny), Contour Detection. • Example: Identifying cracks in a bridge structure during inspection. **4. Image Segmentation**

	• Dividing an image into regions based on characteristics (color, intensity). • Example: Separating roads, buildings, and vegetation in aerial city footage. **5. Object Detection & Classification** • Using AI and machine learning to detect and classify objects (e.g., humans, vehicles). • Tools: YOLO, Haar Cascade, TensorFlow Lite. • Example: Drone recognizing a person in a crowd for search-and-rescue missions. **6. Real-Time Processing in Drones** • Challenges: Limited processing power, battery life, and latency. • Solutions: Edge computing, lightweight models, hardware accelerators (e.g., NVIDIA Jetson). • Example: Drones performing image processing onboard without needing ground control. - **Exercise (5 minutes)** Show a sample aerial image and ask students to: • Identify key features manually (buildings, trees, roads). • Suggest what kind of processing could enhance the image for better analysis.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/01sAkU_NvOY 3. Homework Write a short report (150 words) on how does real-time image processing benefit drone navigation and safety?
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** Why is preprocessing important before analyzing drone images? **2.** How can drones differentiate between a road and a building in a cityscape? **3.** What are some limitations of image processing in drone applications? Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 43	Course Name: UAVs and Drone Technology Topic: Video Processing	Course No.: COM-802(A)

Objectives	At the end of the lesson the student shall be able to: a. Understand the fundamentals of video processing and how it differs from image processing. b. Explain how drones capture, transmit, and process video streams in real time. c. Analyze various video processing techniques used in surveillance, navigation, and target tracking.
Teaching Aids (if any)	a. ICT Usage
Teaching Development	- **Introduction** (5 minutes) - How do drones provide a live feed to a ground station during surveillance?" - Define Video Processing as the analysis and manipulation of video frames to extract meaningful information. - Emphasize its role in applications like FPV (First-Person View), real-time surveillance, and automated decisions. - **Development** (30 minutes) - **1. Basics of Video Processing** - A video = sequence of images (frames) shown quickly. - Frame rate: Measured in FPS (Frames Per Second) – key for smoothness. - Difference from image processing: Involves temporal analysis (motion, tracking). - **2. Drone Video Capture** - Cameras: HD, 4K, thermal, night vision. - Mounted on gimbals for stability. - Example: FPV drone racing – high frame rate video feed to goggles. - **3. Real-time Video Transmission** - FPV systems: 2.4 GHz/5.8 GHz analog or digital video transmission. - Latency issues: Importance of low-latency for quick decision-making.

	- Example: DJI O3 system for low-lag HD video to the controller. - **4. Video Stabilization** - Removing jitter/shake using software or gimbals. - Techniques: Frame alignment, motion estimation. - Example: Aerial footage stabilization for smooth mapping visuals. - **5. Motion Detection and Tracking** - Identifying moving objects across frames. - Techniques: Optical flow, background subtraction. - Example: Surveillance drone following a moving vehicle. - **6. Object Detection in Video** - Combining object detection with video for real-time analysis. - Example: Detecting and tracking a person across video frames using AI. - **7. Video Compression & Storage** - Need for compression: Limited onboard storage and transmission bandwidth. - Codecs: H.264, H.265. - Example: Drones recording in compressed format for extended missions. - **Exercise (5 minutes)** Ask students to summarize this lecture.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Video Lecture https://youtu.be/2OFaBoBxXcY 3. Homework How does real-time video analysis help drones in surveillance and disaster management
Evaluation	Reflective Questions (What, Why, Who?). Allow students to answer and discuss. **1.** Why is low-latency video transmission important for drones? **2.** How does video differ from image processing in application? **3.** What challenges exist in real-time video processing on lightweight drones? Spend 5 minutes to evaluate student assimilation of the lesson contents