CODING TRAINING WITH AVIATION TECHNOLOGIES

Curriculum

Co-funded by the European Union

Content

Introduction

The AVICO project, which involves six countries— Slovakia, Italy, Turkey, Croatia, Serbia, and Portugal—focuses on integrating coding education with Unmanned Aerial Vehicle (UAV) technologies. This transnational report consolidates the findings from each participating country, providing a comprehensive view of the state of UAV and coding education in vocational training across these nations. By combining insights from expert interviews and student surveys, the report aims to identify the key challenges and opportunities within this growing field, offering practical recommendations to enhance educational programs.

UAV technologies are rapidly transforming various industries, from agriculture and logistics to environmental monitoring and urban planning. As these technologies become more integrated into daily operations, there is a growing demand for skilled professionals who not only understand how UAVs work but also have the coding and technical knowledge to innovate with them. Coding education, therefore, plays a crucial role in preparing students for the future workforce, especially in the context of aviation technologies, where the need for both technical and problem-solving skills is ever-increasing.

The AVICO project aims to explore how the combination of coding training and UAV education can better equip students for the future. This report examines the current state of this educational integration, offering a snapshot of the knowledge and experiences of students, the effectiveness of existing teaching methods, and the perspectives of experts in the field. The findings highlight both the successes and challenges faced by educational institutions across the five participating countries, offering a range of insights that can help improve training programs in UAV technology and coding.

Each participating country brings its own educational traditions, technological contexts, and industry relationships to the project. By drawing from national reports, the AVICO project provides a comparative analysis of how coding and UAV education are structured across different vocational settings. The report emphasizes the importance of understanding not only the technical skills needed for success in UAV-related careers but also the pedagogical approaches that best support students' learning and engagement.

Within this context, the AVICO curriculum serves as a key tool for translating research insights into practical teaching solutions. It provides a structured and modular approach to learning, aligned with the European Qualifications Framework (EQF 3–4) and tailored for vocational education settings. By defining clear learning outcomes, knowledge and skill targets, and suggested teaching activities, the curriculum supports teachers in delivering relevant and effective content—while helping students build competencies that match labour market demands.

The curriculum consists of 6 comprehensive modules that combine theory, practical skills, and ethical awareness. These modules were developed through collaboration with educational institutions, experts, and industry stakeholders across all partner countries. Each module is designed to be delivered either in-class, online (via Moodle), or in blended format.

The modules include the following:

COURSE 1: Unmanned Aircraft Training

This hands-on technical module provides in-depth training in drone hardware, propulsion systems, sensors, and autonomous flight. Students learn how to operate UAVs safely, understand meteorological factors, and simulate real flights using training software. The module includes practice in basic block-based coding and explores real-world UAV applications across sectors. It provides a solid technical foundation for students aiming to specialize in drone operations.

COURSE 2: Advanced Python Programming for UAVs

This module builds on students' basic coding skills and takes them into the world of applied programming for drone data processing and automation. Learners work with Python libraries such as NumPy, Pandas, and Matplotlib, gaining skills in data analysis, visualization, and numerical simulations. The module is ideal for students interested in integrating drone technology with software solutions or developing smart drone-based applications for various fields.

COURSE 3: UAV Technologies, Aerodynamics and Programming

This module combines technical knowledge of drone flight with introductory programming skills. Students explore the basic components of UAVs, aerodynamics, and flight performance, while also learning the fundamentals of Python programming and algorithmic thinking. The course builds a bridge between understanding how drones fly and how their behavior can be controlled through software. Learners will develop hands-on coding skills that allow them to customize or simulate UAV missions, preparing them for more advanced applications.

COURSE 4: GIS and Digital Mapping with UAVs

In this module, students learn how UAVs can support geographic data collection, mapping, and planning. It covers the basics of topography, spatial data, and the use of GIS (Geographical Information Systems) to process and visualize UAV outputs. Learners are introduced to digital mapping tools, including online GIS platforms, and understand how drone imagery can be transformed into orthophotos, NDVI vegetation maps, or 3D terrain models. The module emphasizes the link between spatial awareness, digital tools, and real-world applications.

COURSE 5: How to practically Use Drones

This module focuses on the use of UAVs in smart and sustainable agriculture. Students explore how drones can support the precise control of machinery, crop monitoring, and environmental protection. Key topics include GPS-based field navigation, machine movement monitoring, and UAV-supported decision-making to optimize farming inputs and reduce environmental impact. Through practical examples, students understand how technology can make agriculture more efficient, data-driven, and eco-friendly.

COURSE 6: UAV Legislation and Licensing

This module introduces students to the legal and regulatory environment related to unmanned aerial vehicles. It focuses on the legislative framework in the EU and participating countries, especially Slovakia, and highlights the processes of drone registration, licensing, and compliance. Students gain awareness of safety rules, operational restrictions, and ethical

obligations that UAV pilots must respect. The module helps learners understand why legal literacy is essential in any professional UAV activity, whether in agriculture, marketing, or public services.

Each module is structured to include:

- Key subtopics and thematic focus,
- Knowledge and skill learning outcomes,
- Language support strategies,
- Practical hands-on activities and project-based learning,
- Assessment recommendations.

Together, these modules aim to support students not only in developing technical competence but also in enhancing their creativity, teamwork, and confidence in using digital tools for real-world challenges. The modular design allows teachers to adapt content according to classroom needs and local contexts.

This curriculum supports the broader mission of AVICO: to empower vocational schools with the tools and resources to prepare students for careers in emerging technology sectors—and to inspire the next generation of innovators in UAV and coding.

1 Course 1: Unmanned Aircraft Training

1.1 Module 1 – Technologies, Aerodynamics and Performance

Skills focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis

Language focus
Specific terminology related to aerodynamics. -Aerodynamic forces (e.g. lift, drug, thrust) -Technical terms related to performance parameters: - Key drone terminology - Flight terminology and jargon. - Listen, Speak, Write and Present Effectively - Report data - Classify and categorize

1. Introduction to Aerodynamics

1.1 Definition and History of Aerodynamics

1.2 Importance of Aerodynamics in Aviation

1.3 Fundamentals of Aerodynamics

Knowledge focus

- Understand the fundamental principles of aerodynamics and its importance in aviation
- Study the origins and evolution of aerodynamics and its applications
- Discuss the role of aerodynamics in aircraft design, flight performance, and safety
- Introduce the basic principles of aerodynamics, including lift, drag, and thrust
- Classify and categorize

Hands-on Activity

- Write a 2-page report on the definition and history of aerodynamics.
- Design a poster highlighting the importance of aerodynamics in aviation. Write a 2-page report on the definition and history of aerodynamics.

2. Aerodynamic Forces

2.1 Lift and its Components

2.2 Drag and its Components

2.3 Thrust and its Components

Knowledge focus

- Understand the forces that act on an aircraft in flight
- Study the concept of lift, including the role of wings, cambered surfaces, and airflow
- Discuss the concept of drag, including friction, viscous drag, and form drag
- Examine the concept of thrust, including jet engines, propellers, and rocket propulsion

Hands-on Activity

- Calculate the lift force on a small airfoil using the Bernoulli's equation.
- Design a simple aircraft model and calculate its drag force using the drag equation.
- Calculate the thrust force on a small aircraft engine using the thrust equation.

3. Aircraft Performance

3.1 Performance Parameters

3.2 Factors Affecting Performance

3.3 Performance Envelopes

Knowledge focus

- Understand the factors that affect an aircraft's performance
- Study the key performance parameters, including airspeed, altitude, and rate of climb
- Discuss the factors that influence an aircraft's performance, including weight, thrust, and airfoil shape
- Introduce the concept of performance envelopes, including climb, cruise, and stall

Hands-on Activity

- Create a table comparing the performance parameters of two different aircraft models.
- Write a 2-page report on the factors affecting aircraft performance.
- Create a performance envelope for a small aircraft, including the effects of altitude, airspeed, and weight.

1.2 Module 2 – Propulsion Systems

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Technical Vocabulary Terms related to propulsion systems Understanding and using propulsion system jargon Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Introduction to Propulsion Systems

1.1 Fundamentals

1.2 Propulsion System Types

1.3 Propulsion System Design

Knowledge focus

- Understand the design principles of airfoils and their impact on aircraft performance
- Study the shape and structure of airfoils, including cambered surfaces and trailing edges
- Discuss the performance characteristics of airfoils, including lift, drag, and stall
- Examine the use of airfoils in various aircraft designs, including wings, propellers, and helicopter rotors

Hands-on Activity

- Design a simple propulsion system for a model aircraft (e.g. using a toy car engine and a propeller)
- Identify and describe different types of propulsion systems (e.g. reciprocating, turboprop, jet)
- Sketch and describe a basic propulsion system design for a small aircraft
- Reciprocating Engines

2. Reciprocating Engines

2.1 Engine Components

2.2 Engine Performance

2.3 Engine Maintenance

Knowledge focus

- Understanding the principles and operation of reciprocating engines
- Studying the components of reciprocating engines, including cylinders, pistons, and crankshafts
- Discuss the performance characteristics of reciprocating engines, including power output and fuel efficiency
- Examine the maintenance requirements for reciprocating engines, including oil changes and tune-ups

Hands-on Activity

- Assemble and disassemble a simple model engine (e.g. simulated engine)
- Measure and record the performance of a model engine (e.g. toy car engine) under different conditions
- Perform simple maintenance tasks on a model engine (e.g. oil change, spark plug replacement)

1.3 Module 3 – RC, Avionics and Display Systems

Skills focus	Language focus
Critical Thinking -Communication -Collaborative work -Adaptability -Innovation -Problem-Solving -Data Analysis Critical analysis	Technical Vocabulary -Terms related to avionics and display systems -Understanding and using RC system jargon. -Listen, Speak, Write and Present Effectively -Report data Classify and categorize

1. Introduction to RC

1.1 History of RC

1.2 RC Basics

1.3 Types of RC

Knowledge focus

- Understanding the basics of Radio Control (RC) systems, including frequency ranges, transmission methods, and common applications.
- The evolution of RC systems, from early experiments to modern applications.
- Principles of RC systems, including transmitter-receiver relationships, signal transmission, and control surfaces.

Hands-on Activity

- Research and present on the evolution of RC technology
- Build a simple RC model aircraft and demonstrate its basic flight control
- Identify and explain different types of RC systems (e.g. fixed-wing, rotary-wing, gliders)

2. Avionics Systems

2.1 Navigation Systems

2.2 Communication Systems

2.3 Control Systems

Knowledge focus

- Understanding the role of avionics in RC systems, including navigation, communication, and control systems.
- Principles of navigation systems, including GPS, INS, and compasses.
- Overview of communication systems, including radio, satellite, and data link protocols.
- Principles of control systems, including flight control surfaces, autopilot, and stabilization.

Hands-on Activity

- Design and build a simple navigation system for a model aircraft using GPS and sensors
- Set up and test a two-way radio communication system for a model aircraft
- Design and build a simple control system for a model aircraft using servos and electronics

1.4 Module 4 – Autonomous Flight and Ground Station Systems

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Technical Vocabulary Terms related to Autonomous Flight Systems Understanding and using GS systems jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Autonomous Flight Systems

1.1 Sensor Fusion

1.2 Navigation Systems

1.3 Decision-Making Algorithms

Knowledge focus

- Understanding the principles of autonomous flight, including sensor fusion, navigation, and decision-making algorithms.
- How sensors work together to provide a comprehensive view of the environment, including GPS, lidar, radar, and cameras.
- How autonomous vehicles use navigation systems, including GPS, INS, and SLAM, to determine their location and orientation.
- How autonomous systems make decisions, including obstacle avoidance, trajectory planning, and emergency protocols.

Hands-on Activity

- Design a sensor fusion algorithm to combine data from multiple sensors (e.g., GPS, IMU, lidar) to determine the position and velocity of an autonomous vehicle.
- Implement the algorithm in a programming language such as Python or C++.
- Implement a navigation system using a popular navigation library such as OpenStreetMap

or Google Maps. Create a route planning algorithm that takes into account obstacles and traffic patterns.

- Develop a decision-making algorithm for an autonomous vehicle to navigate through a complex environment.
- Use a decision tree or a Markov decision process to make decisions based on sensor data and environmental factors.

2. Ground Station Systems

2.1 Data Transmission

2.2 Communication Protocols

2.3 System Integration

Knowledge focus

- Understanding the role of ground stations in supporting autonomous flight, including data transmission, communication protocols, and system integration.
- How data is transmitted between the autonomous vehicle and the ground station, including wireless communication protocols and data compression techniques.
- How ground stations communicate with autonomous vehicles, including communication protocols such as TCP/IP and UDP.
- How ground stations integrate with autonomous vehicles, including hardware and software integration, and system testing and validation.

Hands-on Activity

- Implement a data transmission protocol (e.g., TCP/IP, UDP) to transmit data from an autonomous vehicle to a ground station. Use a programming language such as Python or C++.
- Design a communication protocol for an autonomous vehicle to communicate with a ground station. Use a protocol such as HTTP or MQTT.
- Integrate a ground station system with an autonomous vehicle system. Use a programming language such as Python or C++.

1.5 Module 5 – Civil Aviation Rules

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Technical Vocabulary Terms related to Aerodromes Understanding and using GS systems jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Aerodromes

1.1 Aerodrome Design and Construction

1.2 Aerodrome Safety and Security

1.3 Aerodrome Management and Operations

Knowledge focus

- Ensure compliance with international standards and guidelines for safe and efficient airport operations.
- Understand the procedures and regulations for ensuring the security and safety of airport operations.
- Learn about the roles and responsibilities of airport management and operational staff in maintaining safe and efficient airport operations.

Hands-on Activity

- Design and construct a simple aerodrome layout using a software such as Autodesk Civil 3D or SketchUp.
- Conduct a safety and security audit of a hypothetical aerodrome using a checklist provided.
- Develop a management and operations plan for a small aerodrome using a template provided.

2. Air Traffic Control

2.1 Air Traffic Control Procedures

2.2 Air Traffic Control Equipment and Systems

2.3 Air Traffic Control Safety and Emergency Procedures

Knowledge focus

- Understand the procedures and protocols for air traffic control, including communication, navigation, and separation of aircraft.
- Learn about the equipment and systems used in air traffic control, including radar, navigation aids, and communication systems.
- Understand the procedures and protocols for handling emergency situations in air traffic control, including crisis management and incident reporting.

Hands-on Activity

- Participate in a simulated air traffic control exercise, providing clearances and instructions to pilots using a software such as Flight Simulator or ATC-Simulator.
- Identify and troubleshoot common air traffic control equipment and system malfunctions using a troubleshooting guide provided.
- Develop an emergency response plan for an air traffic control center using a scenario provided.

1.6 Module 6 – Meteorology and Flight Safety

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Technical Vocabulary Terms related to Weather Meteorology and Flight Safety Understanding and using ATC jargon Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Aviation Weather Services

1.1 Weather Forecast

1.2 Weather Observation

1.3 Weather Warning

Knowledge focus

- Understanding the importance of weather services in flight safety, types of weather services and their limitations
- Understanding the accuracy and reliability of weather forecasts, factors affecting forecast accuracy
- Understanding the importance of weather observation in aviation, types of weather observation methods
- Understanding the significance of weather warnings in flight safety, types of weather warnings.

Hands-on Activity

- Provide a weather forecast for a specific airport (e.g. JFK, LAX, etc.) using a weather service provider (e.g. METAR, TAF, etc.)
- Identify and explain the different types of weather forecasts (e.g. short-term, medium-term, long-term)
- Create a simple weather forecast using a graphical weather map.

2. Meteorology

2.1 Clouds

2.2 Precipitation

2.3 Weather Phenomena

Knowledge focus

- Understanding the basics of meteorology, types of clouds, precipitation, and weather phenomena
- Understanding the different types of clouds, their characteristics, and their effects on flight safety
- Understanding the different types of precipitation, their intensity, and their effects on flight safety
- Understanding the different types of weather phenomena, such as thunderstorms, icing, and turbulence.

Hands-on Activity

- Identify and describe the main types of clouds (e.g. cirrus, cumulus, stratus, etc.)
- Explain the concept of precipitation (e.g. rain, snow, hail, etc.) and its effects on aviation
- Create a diagram illustrating the water cycle and its relation to precipitation.

1.7 Module 7 – Basic Level Design

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Technical Vocabulary Terms related to Aircraft Design Understanding and using ATC jargon Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Aircraft Design Fundamentals

1.1 Aerodynamic Considerations

1.2 Aircraft Performance Characteristics

1.3 Aircraft Design Philosophy

Knowledge focus

- Introduction to Aircraft Design, Aerodynamics, Aircraft Performance
- Lift, Drag, Thrust, Weight, Airfoil Shape, Wing Design
- Climb and Descent Rates, Cruise Speed, Range, Endurance, Ceiling
- Design Requirements, Design Constraints, Design Trade-Offs.

Hands-on Activity

- Design a wing shape using CAD software to optimize lift and drag coefficients.
- Calculate the climb and descent rates of an aircraft using the aircraft's thrust and weight.
- Create a design brief for an aircraft, including design requirements and constraints.

2. Aircraft Structural Design

2.1 Aircraft Structural Components

2.2 Structural Analysis and Testing

2.3 Fatigue and Damage Tolerance

Knowledge focus

- Understanding the basics of meteorology, types of clouds, precipitation, and weather phenomena
- Understanding the different types of clouds, their characteristics, and their effects on flight safety
- Understanding the different types of precipitation, their intensity, and their effects on flight safety
- Understanding the different types of weather phenomena, such as thunderstorms, icing, and turbulence.

Hands-on Activity

- Identify and describe the main types of clouds (e.g. cirrus, cumulus, stratus, etc.)
- Explain the concept of precipitation (e.g. rain, snow, hail, etc.) and its effects on aviation
- Create a diagram illustrating the water cycle and its relation to precipitation.

1.8 Module 8 – Maintenance and Repair

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Technical Vocabulary Terms related to Aircraft Systems, Maintenance and Repair Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Aircraft Systems

1.1 Electrical System

1.2 Hydraulic System

1.3 Pneumatic System

Knowledge focus

- Understanding the various systems that make up an aircraft, including electrical, hydraulic, pneumatic, and fuel systems.

- Knowledge focus: Understanding the electrical system's components, including generators, batteries, and circuit breakers, and how they work together to power the aircraft.
- Knowledge focus: Understanding the hydraulic system's components, including pumps, motors, and actuators, and how they work together to operate aircraft systems.
- Knowledge focus: Understanding the pneumatic system's components, including compressors, valves, and ducting, and how they work together to provide air pressure for aircraft systems.

Hands-on Activity

- Identify the main components of the electrical system on a given aircraft. * Diagram the electrical circuit for a specific system (e.g. lighting, avionics). * Troubleshoot a simple electrical fault (e.g. faulty circuit breaker).
- Identify the main components of the hydraulic system on a given aircraft. * Diagram the hydraulic circuit for a specific system (e.g. brakes, landing gear). * Troubleshoot a simple hydraulic fault (e.g. faulty pump).
- Identify the main components of the pneumatic system on a given aircraft. * Diagram the pneumatic circuit for a specific system (e.g. air conditioning, pressurization). * Troubleshoot a simple pneumatic fault (e.g. faulty compressor).

2. Aircraft Inspection and Testing Structural Design

1.4 Pre-Flight Inspection

1.5 In-Flight Testing

1.6 Post-Flight Inspection

Knowledge focus

- Understanding the importance of regular inspections and testing to ensure aircraft safety and airworthiness.
- Understanding the pre-flight inspection process, including visual and mechanical inspections, and how to identify potential issues before flight.
- Understanding the importance of in-flight testing, including engine run-up, systems check, and other checks to ensure aircraft performance and safety.
- Understanding the post-flight inspection process, including documentation and reporting of any issues found during the flight.

Hands-on Activity

- Conduct a pre-flight inspection on a given aircraft, identifying and reporting any defects or issues. * Use a checklist to ensure all critical items are inspected.
- Conduct a series of in-flight tests on a given aircraft, including checks on systems and performance. * Record and report any issues or defects found during the tests.
- Conduct a post-flight inspection on a given aircraft, identifying and reporting any defects

or issues. * Use a checklist to ensure all critical items are inspected.

1.9 Module 9 – Using a Drone with a Simulator

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Technical Vocabulary Terms related to Drone Simulators and Drone Operations Key drone terminology Flight terminology and jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Introduction to Drone Simulators

1.1 Why Use a Drone Simulator?

1.2 Simulator Interface Overview

1.3 Simulator Limitations

Knowledge focus

- Understanding the benefits of using a drone simulator, getting familiar with the simulator interface, and understanding the simulator's limitations.
- The importance of training before flying a real drone, reducing the risk of accidents, and improving pilot skills.
- Navigation and layout of the simulator, understanding the different modes and tools available, and getting familiar with the user interface.
- Understanding the limitations of the simulator, including weather and environmental limitations, and how they may affect the simulation experience.

Hands-on Activity

- Write a short essay (max 100 words) on the advantages of using a drone simulator.
- Take a screenshot of the simulator interface and identify the different components (e.g. navigation panel, flight controls, etc.).

- Create a list (max 5 items) of potential limitations of a drone simulator.

2. Basic Drone Operations

2.1 Drone Controls and Modes

2.2 Basic Flight Maneuvers

2.3 Emergency Procedures

Knowledge focus

- Understanding the basic controls and operations of a drone, including takeoff, landing, and basic flight maneuvers.
- Understanding the different modes and controls available on the drone, including altitude and speed settings, and how to use them effectively.
- Practicing basic flight maneuvers, including takeoff and landing, hovering, and basic turns.
- Understanding emergency procedures, including what to do in case of a loss of signal, low battery, or other unexpected events.

Hands-on Activity

- Practice navigating through the simulator's controls and modes (e.g. switching between modes, adjusting settings, etc.).
- Complete a series of basic flight maneuvers (e.g. takeoff, landing, turns, etc.) using the simulator.
- Practice responding to emergency situations (e.g. engine failure, system failure, etc.) using the simulator.

3. ADVANCE Drone Operations

3.1 Aerial Photography and Videography

3.2 Complex Flight Maneuvers

3.3 Advanced Pilot Techniques

Knowledge focus

- Understanding advanced drone operations, including aerial photography and videography, and complex flight maneuvers.
- Understanding the basics of aerial photography and videography, including camera settings and techniques.
- Practicing complex flight maneuvers, including barrel rolls, Immelmann turns, and other advanced aerobatic maneuvers.
- Understanding advanced pilot techniques, including precision flying, and how to use them to improve flight skills.

Hands-on Activity

- Use the simulator to capture aerial footage or photos of a predetermined scene (e.g. a park, a building, etc.).
- Complete a series of complex flight maneuvers (e.g. tight turns, slow flight, etc.) using the simulator.
- Practice advanced pilot techniques (e.g. formation flying, precision landing, etc.) using the simulator.

1.10 Module 10 – Codable Drone Types

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Technical Vocabulary Terms related to Drone Design, Propulsion Key drone terminology Flight terminology and jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Drone Design

1.1 Aerodynamics

1.2 Material Selection

1.3 Structural Integrity

Knowledge focus

- Understanding the importance of design principles in creating a functional and efficient drone.
- The importance of air resistance and lift in drone flight.
- The selection of materials for drone construction, considering factors like weight, strength, and durability.
- Ensuring the structural integrity of the drone to withstand various environmental conditions.

Hands-on Activity

- Design a drone with a specific purpose (e.g., aerial photography) using CAD software.

- Aerodynamics Measure and record the lift and drag forces of a drone wing using a wind tunnel or CFD simulation.
- Material Selection Choose and justify the selection of materials for a drone's frame, propellers, and other components.
- Structural Integrity Analyze and design a drone's structural integrity using Finite Element Analysis (FEA) software.

2. Drone Propulsion

2.1 Electric Motors

2.2 Gasoline Engines

2.3 Hybrid Propulsion

Knowledge focus

- Understanding the different types of propulsion systems used in drones.
- The advantages and limitations of electric motors in drone propulsion.
- The pros and cons of using gasoline engines in drones, including noise and emissions.
- The benefits and challenges of combining different propulsion systems in drones.

Hands-on Activity

- Drone Propulsion Build and test a simple drone propulsion system using an electric motor and propeller.
- Electric Motors Test and compare the performance of different electric motors used in drones.
- Gasoline Engines Build and test a simple gasoline-powered drone using an internal combustion engine.
- Hybrid Propulsion Design and test a hybrid propulsion system combining electric and gasoline power.

1.11 Module 11 – Basic Drone Coding (block-based)

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Technical Vocabulary Terms related to Drone Coding Key drone terminology Flight terminology and jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Introduction to Drone Coding

1.1 Introduction to block-based coding

1.2 Basic coding concepts

1.3 Drone programming platforms

Knowledge focus

- Understanding the basics of block-based coding and its applications in drone programming
- Understanding the concept of block-based coding and its advantages
- Understanding basic coding concepts such as loops, conditionals, and variables
- Understanding popular block-based coding platforms for drone programming.

Hands-on Activity

- Create a basic block- based code using a platform such as Scratch or MakeCode, demonstrating understanding of block-based coding concepts.
- Write a simple block-based code using Scratch or MakeCode, and explain the basics of block-based coding.
- Write a short program using a programming language such as Python or Java, demonstrating understanding of basic coding concepts such as variables, loops, and conditional statements.
- Research and compare three different drone programming platforms (e.g. Python, Java, or Scratch), and write a short report on their features and limitations.

2. Drone Hardware and Software

2.1 Drone hardware components

2.2 Drone software components

2.3 Integration of hardware and software

Knowledge focus

- Understanding the hardware and software components of a drone and their roles in programming
- Understanding the different components of a drone, such as sensors, motors, and batteries
- Understanding the different software components of a drone, such as flight controllers and operating systems.

Hands-on Activity

- Identify and describe the main components of a drone (flight controller, sensors, motors) and explain how they work together to control the drone.
- Design and describe a drone's hardware components, including sensors, cameras, and flight controllers.
- Write a short program using a programming language such as Python or Java, demonstrating understanding of drone software components such as flight control algorithms and sensor integration.
- Write a code that integrates a sensor GPS, accelerometer, or gyroscope) into a drone program using a programming platform such
- as Python or Java, and demonstrate understanding of sensor integration.

1.12 Module 12 – Drone Coding Applications

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Technical Vocabulary Terms related to Drone Coding Applications Key drone terminology Flight terminology and jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Drone Flight Control

1.1 Sensor Integration

1.2 Flight Modes

1.3 Stabilization Algorithms

Knowledge focus

- Understanding the basics of drone flight control, including sensor integration, flight modes, and stabilization algorithms.
- How to integrate various sensors (e.g., GPS, accelerometers, gyroscopes, magnetometers) to enable precise flight control and navigation.
- Understanding the different flight modes (e.g., manual, autonomous, follow-me) and how to implement them in a drone coding application.
- The importance of stabilization algorithms (e.g., PID, Kalman filter) in ensuring stable and smooth drone flight.

Hands-on Activity

- Write a Python script to integrate a lidar sensor with a drone's flight control system. Use a library such as OpenCV to process sensor data.
- Design and implement a flight mode selection system for a drone using a microcontroller such as Arduino. Use a graphical user interface (GUI) to display the available flight modes.

- Implement a PID controller in C++ to stabilize a drone's roll and pitch movements. Use a simulation environment such as Gazebo to test the algorithm.
- Train a pre-trained YOLOv3 model on a dataset of objects using a Python library such as TensorFlow. Use the trained model to detect objects in a video stream from a drone's camera.

2. Computer Vision

2.1 Object Detection

2.2 Object Tracking

2.3 Object Recognition

Knowledge focus

- Using computer vision techniques to enable drone applications such as object detection, tracking, and recognition.
- How to use computer vision techniques (e.g., YOLO, Haar cascades) to detect objects (e.g., people, vehicles, obstacles) in the drone's field of view.
- How to track objects (e.g., people, vehicles) using computer vision techniques, including Kalman filter-based tracking and machine learning-based tracking.
- The role of machine learning and deep learning in object recognition, including image classification and object detection using neural networks

Hands-on Activity

- Implement a Kalman filter in Python to track the position and velocity of an object detected in a video stream from a drone's camera. Use a library such as OpenCV to process the video data.
- Train a pre-trained ResNet50 model on a dataset of objects using a Python library such as TensorFlow. Use the trained model to recognize objects in a video stream from a drone's camera.
- Implement a neural network in Python using a library such as TensorFlow to detect objects in a video stream from a drone's
- camera. Use a dataset such as PASCAL VOC to train the model.
- Implement a recurrent neural network in Python using a library such as TensorFlow to track the position and velocity of an object detected in a video stream from a drone's camera. Use a dataset such as KITTI to train the model.

2 Course 2: Python Programming for UAVs

2.1 Module 1 – Introduction to Python & Programming Fundamentals

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Specific terminology related Aerodynamics, propulsion and Flight Dynamics Technical terms related to UAV performance Key drone terminology Flight terminology and jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Introduction to Python & Programming Fundamentals

1.1 *What is Python and its advantages?*

1.2 *Setting up the Python environment*

1.3 *Basic syntax: variables, data types (numbers, strings, booleans), operators*

1.4 *Input/output: print (), input ()*

1.5 *Control flow:*

1.6 *-Conditional statements (if, elif, else)*

Knowledge focus

- Understand the core concepts of programming and Python's syntax.
- Write simple programs that use variables, perform calculations ,and interact with the user.
- Utilize control flow to create programs with decision-making and repetition.
- -Define and use functions to organize code and promote.

Hands-on Activity

- **Project:** Build a simple UAV aerodynamic model.

- **Functionality:** Set UAV parameters (e.g., wing area, lift coefficient, air density, velocity). Implement functions to calculate drag coefficient. Display the calculated results to the user in a clear and informative way. Allow the user to explore how changing parameters affects the results
- **Goal:** Reinforce understanding of variables, data types (floats, strings), operators, input/output (input (), print ()), and functions. Practice modular code design by breaking down calculations into separate functions. Apply basic mathematical operations in a practical context. Introduce the concept of parameterization and sensitivity analysis
- **Additional Considerations:** Simplify the Model: For an introductory module, focus on a simplified aerodynamic model rather than a highly complex one. Provide Formulas: Give students the necessary formulas for aerodynamic parameters or guide them to find appropriate resources. Error Handling (Optional): If time allows, introduce basic error handling (e.g., checking for valid input types) to make the calculator more robust.

2.2 Module 2 – Data Structures &Algorithms

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Specific terminology related Aerodynamics, propulsion and Flight Dynamics. Technical terms related to UAV performance Key drone terminology Flight terminology and jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Data Structures & Algorithms

1.1 Lists: creating, indexing, slicing, methods (append, insert, pop, etc.)

1.2 Tuples: immutability, use cases

1.3 Dictionaries: key-value pairs, accessing elements,

1.4 Sets: unordered collections, unique elements, operations

1.5 Strings: indexing, slicing, formatting, common methods

1.6 Basic algorithms:

1.7 -Searching (linear, binary)

Knowledge focus

- Master the use of Python's built-in data structures to store and manipulate data.
- Understand the differences between mutable and immutable datatypes.
- Apply basic algorithms to solve common programming tasks
- Gain awareness of algorithm efficiency and time complexity (optional)

Hands-on Activity

- **Project**: Create a program to manage a UAV list.
- **Functionality:** Store aircraft type and its main parameters, in a dictionary or list of dictionaries. Implement features like adding new parameters, updating information, and deleting them.
- **Goal:** Practice working with lists, dictionaries, and basic algorithms like searching and sorting.

2.3 Module 3 – Object-Oriented Programming (OOP)

Skills focus	Language focus
Critical Thinking -Communication -Collaborative work -Adaptability -Innovation -Problem-Solving -Data Analysis Critical analysis	Specific terminology related Aerodynamics, propulsion and Flight Dynamics. Technical terms related to UAV performance Key drone terminology Flight terminology and jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Object-Oriented Programming (OOP)

1.1 Introduction to OOP concepts: classes, objects, attributes, methods

1.2 Defining classes and creating objects

1.3 Constructors (in it_) and instance methods

1.4 Regulations and Safety

1.5 Encapsulation and information hiding

1.6 Inheritance: creating subclasses, overriding methods

Knowledge focus

- Introduction to OOP concepts: classes, objects, attributes, methods
- Defining classes and creating objects
- Constructors (__in it_) and instance methods
- Regulations and Safety
- Encapsulation and information hiding
- Inheritance: creating subclasses, overriding methods
- Polymorphism: using objects of different classes interchangeably.

Hands-on Activity

- **Project:** Design an aircraft maintenance management system.
- **Functionality:** Create classes for aircraft, its main systems and its maintenance requirements. Implement methods for adding them and store and retrieve maintenance activities.
- **Goal:** Apply OOP principles to design a modular and extensible system, practicing concepts like classes, objects, attributes, methods, and inheritance

2.4 Module 4 – File Handling, Exceptions & Modules

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Specific terminology related Aerodynamics, propulsion and Flight Dynamics Technical terms related to UAV performance Key drone terminology Flight terminology and jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. File Handling, Exceptions &Modules

1.1 FileI/O, Opening and closing files Reading and writing text files

1.2 Working with CSV and JSON files

1.3 Exception Handling

1.4 Common exceptions (File Not Found Error, Type Error, etc.)

1.5 Try, except, finally blocks

1.6 Raising custom exceptions

1.7 Modules and packages: Importing modules and functions

1.8 Creating and organizing modules

Knowledge focus

- Read from and write data to files in various formats.
- Gracefully handle errors and exceptions to prevent program crashes.
- Modularize code for better organization and maintainability.
- Understand how to use and create modules and packages.

Hands-on Activity

- **Project:** Develop a program to analyze weather data
- **Functionality:** Read weather data from a CSV Or JSON file (e.g., temperature, humidity, precipitation). Calculate statistics (averages, maximums, minimums) and potentially visualize the data using Matplotlib.
- **Goal:** Practice reading and writing files, handling potential errors (e.g., missing data), and organizing code into modules.

2.5 Module 5 – Numerical Computing with NumPy

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Specific terminology related Aerodynamics, propulsion and Flight Dynamics Technical terms related to UAV performance Key drone terminology Flight terminology and jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Numerical Computing with NumPy

1.1 NumPy arrays: creation, indexing, slicing, reshaping

1.2 Array operations: arithmetic, broadcasting, vectorization

1.3 Universal functions (ufuncs): fast element-wise operations

1.4 Random number generation

1.5 Linear algebra with NumPy: matrix operations, dot product, etc.

Knowledge focus

- Efficiently work with numerical data using NumPy arrays
- Leverage NumPy's capabilities for fast mathematical operations.
- Perform common linear algebra tasks using NumPy.

Hands-on Activity

- **Project:** Simulate an ATC scenario.
- **Functionality:** Use NumPy to generate random numbers representing a simple APP scenario.
- **Goal:** Apply NumPy's random number generation and array manipulation capabilities to a practical scenario.

2.6 Module 6 – Data Analysis with Pandas

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Specific terminology related Aerodynamics, propulsion and Flight Dynamics Technical terms related to UAV performance Key drone terminology Flight terminology and jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Data Analysis with Pandas

1.1 Series and Data Frame: creating, indexing, selecting data

1.2 Data cleaning and preparation: handling missing values, duplicates, etc.

1.3 Data manipulation: filtering, sorting, grouping, aggregating

1.4 Data analysis: descriptive statistics, correlations

1.5 Reading and writing data from various sources (CSV, Excel, SQL, etc.)

Knowledge focus

- Master the use of Pandas for data cleaning, manipulation, and analysis.
- Load and save data from different file formats
- Perform exploratory data analysis to gain insights.

Hands-on Activity

- **Project:** Analyze a daily airport data set (departures and arrives)
- **Functionality:** Load the data set into a Pandas Data Frame, clean and preprocess the data, explore relationships between variables, and potentially create visualizations to summarize findings
- **Goal:** Practice data cleaning, manipulation, analysis, and visualization using Pandas.

2.7 Module 7 – Scientific Computing with SciPy

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Specific terminology related Aerodynamics, propulsion and Flight Dynamics Technical terms related to UAV performance Key drone terminology Flight terminology and jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Scientific Computing with SciPy

1.1 Introduction to SciPy and its submodules

1.2 Optimization: finding minima and maxima of functions.

1.3 Integration: numerical integration techniques

1.4 Interpolation: estimating values between data points

1.5 Signal processing: Fourier transforms, filtering, etc.

1.6 Image processing: basic operations, filtering, transformations

Knowledge focus

- Apply SciPy's tools for solving scientific and engineering problems.
- Understand the fundamentals of numerical methods for optimization, integration, and interpolation.
- Perform basic signal and image processing tasks

Hands-on Activity

- **Project:** Model a simple UAV
- **Functionality:** Use SciPy's numerical integration and optimization tools to simulate the UAV motion under different conditions (take-off, climb, cruise). Visualize the results using Matplotlib.

- **Goal:** Apply SciPy's scientific computing capabilities to a real-world problem.

2.8 Module 8 – Data Visualization with Matplotlib (Pyplot)

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Specific terminology related Aerodynamics, propulsion and Flight Dynamics Technical terms related to UAV performance Key drone terminology Flight terminology and jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Data Visualization with Matplotlib (Pyplot)

1.1 Introduction to Matplotlib and Pyplot

1.2 Creating various types of plots: line, scatter, bar, histogram, pie, etc.

1.3 Customizing plot appearance: titles, labels, legends, colors, styles

1.4 Creating subplots and multiple figures

1.5 Annotating plots with text, arrows, and shapes

1.6 Saving plots to different file formats

Knowledge focus

- Create visually appealing and informative plots to communicate data insights.
- Customize plot aesthetics to meet specific requirements.
- Effectively use Matplotlib and Pyplot for exploratory data analysis and presentation.

Hands-on Activity

- **Project:** Create an interactive dashboard to visualize UAV motion data
- **Functionality:** Use Matplotlib and Pyplot to create various plots (line charts, bar charts, scatter plots, etc.) that allow users to interact with the data (e.g., zoom, pan, select data

points).

- **Goal:** Combine Matplotlib's plotting capabilities with interactive elements to create a more engaging and informative data visualization experience.

3 Course 3 - UAV Technologies, Aerodynamics and Programming

3.1 Module 1 – UAV Technologies

Skills focus	Language focus
Critical Thinking Communication Collaborative work Adaptability Innovation Problem-Solving Data Analysis Critical analysis	Specific terminology related to drones and ESCs Multi-rotor configurations Technical terms related to multi-rotor performance Terms related to battery chemistry, specifications, and handling, EXC Key terms: modulation, demodulation, frequency, wavelength, bandwidth, gain, noise figure Key drone terminology Flight terminology and jargon. Listen, Speak, Write and Present Effectively Report data Classify and categorize

1. Different types of multi-rotor UAVs

1.1 Different configurations of multi-rotor UAVs

1.2 Advantages and disadvantages of each type

1.3 Applications specific to each type of multi-rotor UAV

Knowledge focus

- Understand the different configurations of multi-rotor UAVs (quadcopters, hexacopters, octocopters, tricopters)
- Learn Advantages and disadvantages of each type.
- Explore applications specific to each type of multi-rotor UAV.

Hands-on Activity

- Providing students with images or models of different multi-rotor UAVs. Having them identify the configuration (number and arrangement of rotors) and list potential applications for each type.

- Applying knowledge of multi-rotor types to real-world situations and understand the practical considerations in UAV selection.

2. Flight terminology and Roles of ESC

2.1 Drone flight terminology

2.2 Roles and functions of Electronic Speed Controllers (ESCs)

Knowledge focus

- Understand key drone flight terminology
- Comprehend the roles and functions of Electronic Speed Controllers (ESCs) in drones.

Hands-on Activity

- Drone Component Identification; Identifying and labeling drone components.
- ESC Function Demonstration; Connecting the ESC to a motor and battery, then use the throttle controller to demonstrate how changing throttle settings affects motor speed.

3. Drone flight

3.1 Introduction to Drones

3.2 Drone Component

3.3 Aerodynamics and Flight Mechanics

3.4 Regulations and Safety

Knowledge focus

- Understand the parts of a drone (frame, motors, ESCs, propellers, flight controller, battery, GPS, camera, etc.).
- Explore basic electronics and circuitry.

Hands-on Activity

- Using flight simulators for practice.
- Assembling a drone from a kit.
- Creating pre-flight and post-flight reports.

4. LiPo Batteries

4.1 Introduction to LiPo Batteries

4.2 Basic principles of LiPo battery chemistry.

4.3 Safety and Handling issues

4.4 Charging and Discharging

Knowledge focus

- Choose the right LiPo battery for specific applications.
- Understand specifications and ratings.
- Set up and using balance chargers.
- Monitore charge cycles and balancing cells.
- Identify common issues and their causes.
- Explore basic repair techniques (e.g., connector replacement.

Hands-on Activity

- Inspecting various LiPo batteries for physical damage and wear
- Practicing proper handling and storage techniques
- Using software tools to log and analyze charge/discharge cycles.
- Preparing Diagrams and charts explaining battery chemistry and specifications.

5. GPS in flight

5.1 Introduction to GPS Technology

5.2 GPS in Aviation

5.3 Components and Functionality

5.4 Accuracy and Limitations

Knowledge focus

- Understand how GPS works: satellites, receivers, and triangulation.
- Understand GPS receivers and antennas.
- Explore role of GPS in modern aviation.
- Install and configure GPS receivers in aircraft.
- Setting up waypoints and flight paths.
- Use GPS for pre-flight planning.
- Create and inputting flight plans.

Hands-on Activity

- GPS Navigation Practice: Using a flight simulator with GPS capability to navigate a predefined route, plotting waypoints and making course corrections as needed.
- Mapping Exercises: Plotting and following a route on an aeronautical chart using GPS coordinates.

6. Radio receiver and transmitter systems

6.1 Fundamental Concepts

6.2 Technical Components

6.3 Standards and Regulations

Knowledge focus

- Understand electromagnetic waves and spectrum
- Understand Frequency modulation (FM) and amplitude modulation (AM)
- Understand basic principles of antennas and propagation
- Explore types of transmitters and receivers
- Learn modulation and demodulation techniques
- Use amplifiers, mixers, oscillators, and filters
- Understand signal processing and noise reduction
- Learn international and national radio frequency regulations.

Hands-on Activity

- Constructing a basic AM/FM radio receiver from a kit
- Designing and building a simple RF transmitter circuit
- Experimenting with different antenna designs to optimize reception.

7. Pre-flight checks

7.1 Regulations and Guidelines

7.2 UAV Systems

7.3 Weather Conditions

7.4 Flight Planning

Knowledge focus

- Understand FAA regulations or relevant local aviation authorities' rules.
- Be aware of no-fly zones, height restrictions, and necessary permits.
- Learn components of a UAV motors, propellers, flight controllers, batteries, sensors, and cameras.
- Explore different types of UAVs and their uses.
- Understand the Impact of weather on UAV operations: wind, rain, temperature, and visibility.
- Explore tools for weather forecasting and real-time weather updates.
- Understand flight plans and how to create them.
- Explore importance of GPS and mapping software.

Hands-on Activity

- Conducting a thorough pre-flight check, including visual inspection of the UAV for any damage or wear.
- Checking battery levels, propeller integrity, and connection security.
- Using flight simulators to practice UAV operation and pre-flight procedures.

8. Assembling a quadcopter from commercially available parts

8.1 Basics of Aerodynamics

8.2 Principles of Flight Control

8.3 Electronics and Circuitry

8.4 Types of Quadcopters

Knowledge focus

- Understand how lift, thrust, drag, and weight interact.
- Explore concepts like yaw, pitch, roll, and stabilization
- Understand basics of current, voltage, power, and circuit components (resistors, capacitors, etc.)
- Understand different quadcopter configurations (X-frame, H-frame, etc.)

Hands-on Activity

- Practicing identifying and testing different parts of a quadcopter using multimeters and other tools.
- Building the frame and mounting motors and other components.
- Soldering motor wires to ESCs, and connecting ESCs to the flight controller.
- Installing and configuring the flight controller, including firmware updates.

9. Required Software and controller

9.1 Control Systems

9.2 Sensors and Instrumentation

9.3 Communication Systems Object Tracking

Knowledge focus

- Learn about PID controllers, stabilization algorithms, and navigation systems.
- Understand radio frequency communication, telemetry, and data transmission.
- Learn about different sensors used in UAVs, such as gyroscopes, accelerometers, magnetometers, barometers, and cameras used in UAV navigation.
- Explore data logging and post-flight analysis.

Hands-on Activity

- Assembling a quadcopter from a kit to understand the physical components and their integration.
- Integrating and calibrate sensors (IMU, GPS, cameras) into a UAV and test their functionality.
- Collecting flight data using onboard systems and analyze it for performance improvements.

10. Basic safety and legal requirements

10.1 Understanding Regulations

10.2 Safety Protocols

10.3 Operational Guidelines

Knowledge focus

- Study the local, national, and international regulations governing UAV operations (e.g., FAA regulations in the U.S., EASA regulations in Europe).
- Learn about restricted airspace, no-fly zones, and altitude limits.
- Understand pre-flight, in-flight, and post-flight safety checks.
- Familiarize with emergency procedures and risk management strategies.
- Study guidelines on safe operation near people, buildings, and other aircraft.

Hands-on Activity

- Using flight simulation software to practice flying in various conditions and adhering to safety protocols.
- Performing real-time risk assessments and implement safety measures during UAV flights.
- Attending workshops on UAV safety and legal requirements.

4 Course 4: GIS and Digital Mapping with UAVs

4.1 Module 1 – GIS and Digital mapping

Skills focus	Language focus
Communication Troubleshooting Data analysis Working with text Recording data	Professional topographical terminology and cartography, photogrammetry, GIS, Technical vocabulary of GIS Classification and categorization of GIS concepts Professional GIS terminology Professional terminology of spatial planning

1. Topography

1.1 Cartography

1.2 Photogrammetry

Knowledge focus

- Understand the basic principles of topography
- Describe the shapes, distribution and properties of natural and socioeconomic objects (soil, water, relief, settlements, communications, industrial and agricultural buildings, etc.) in the country.
- Describe the display of objects and phenomena using a digital image
- Define a set of methods using geodetic coordinates.

Hands-on Activity

- Develop a topographical map on a scale of 1:5000.
- Make a topographic map based on direct measurements in the field.
- Process cartographic data in the form of digitization.

- Take a photogrammetric aerial photograph.

2. GIS

2.1 Components of GIS

2.2 GIS methods

2.3 GIS creation procedure

Knowledge focus

- Analyze spatial information
- Understand the essentials of GIS
- Define the usability of GIS in practice
- Define the basic components of GIS
- Work with GIS methods
- Apply knowledge in the creation of GIS of the territory and the country

Hands-on Activity

- Determine, according to the basic map of the real estate cadastre, the owners of land and real estate based on the ownership certificate
- Calculate the slope of the terrain according to contour lines
- Draw contours in the terrain map

3. Digital spatial plan

3.1 The process of digitization of the territorial plan

Knowledge focus

- Define the territorial plan
- Understand the spatial plan
- Know the territorial plan in the form of digitization

Hands-on Activity

- Develop a spatial plan according to the aspect of the environment, taking into account settlements, transport and technical infrastructure, elements of the natural and environment.

4. Map portal web GIS

4.1 The process of creating a map portal

Knowledge focus

- Know the workflow of creating a map portal.

Hands-on Activity

- Browse the map portal
- Present information is displayed in the form of an interactive map composition.

5 Course 5: How to practically Use Drones

5.1 Module 1 – Using UAVs for Data Collection, Visualization and Storytelling

Skills focus
Observation and analysis Categorization and classification Task sequencing and planning Digital planning and tool selection Critical and comparative thinking Matching tools to purpose Interpreting and evaluating data and visuals Risk awareness and responsible decision-making Ethical judgment and legal understanding Media editing and digital content design Storyboarding and creative communication Cross-disciplinary analysis and profile building Teamwork, reporting, and reflective feedback

Language focus
Drone-related terminology and system components Technical planning language and sequencing Describing differences and comparing outputs Legal and ethical expressions Vocabulary for visuals and digital outputs Presenting ideas, data, and digital content clearly Vocabulary for media production and storytellingExpressing opinions, giving feedback, and participating in discussions Job roles and sector-specific terminology Reporting observations and reflecting on learning outcomes

1. Why Use Drones

1.1 UAV applications in different sectors

1.2 Benefits of UAV use

1.3 Components of a UAV system

Knowledge focus

- Understand where and why UAVs are used.
- Learn about UAV systems and components.
- Identify key areas of drone application (agriculture, marketing, mapping).

Hands-on Activity

- Create a simple infographic about UAV applications.

- Identify drone parts and their functions using a labeled diagram.

2. Planning Autonomous Missions Using Ground Control Software

2.1 Basics of Ground Control Software (GCS)

2.2 Planning a mission step-by-step

2.3 Common errors and pre-flight checklist

Knowledge focus

- Understand how autonomous drone flights work.
- Learn how to use GCS to plan UAV missions.
- Recognize common issues in flight planning.

Hands-on Activity

- Plan a simple UAV mission in a GCS simulator.
- Complete a UAV mission checklist worksheet.

3. Sensors and Data Collection

3.1 Types of sensors (RGB, NDVI, thermal)

3.2 Selecting the right sensor for the mission

3.3 Influence of flight height and speed on data

Knowledge focus

- Identify different types of sensors and what data they collect.
- Understand how flight altitude and speed affect data quality.
- Compare sensor types and applications.

Hands-on Activity

- Match sensors to real-life missions.
- Analyze example outputs from different sensors.

4. Processing Outputs: Maps, Visualizations, Videos

4.1 Data transfer and file organization

4.2 Creating maps, 3D models, videos

4.3 Selecting outputs for target audience

Knowledge focus

- Know how to process UAV-collected data.
- Understand differences between orthophotos, NDVI maps, 3D models.
- Select the appropriate format for purpose.

Hands-on Activity

- Compile an NDVI map in software.
- Edit a short video using drone footage.
- Compare 3D model vs. map outputs.

5. UAV in Marketing and Visual Storytelling

5.1 Aesthetic principles of drone visuals

5.2 Composition, lighting, storytelling

5.3 Promotional video basics

Knowledge focus

- Understand how drones are used in media and marketing.
- Learn to design a visual story using UAV.
- Identify visual appeal and message.

Hands-on Activity

- Create a storyboard for a promotional UAV video.
- Analyze two drone marketing videos.

6. Comparison of UAV Use in Agriculture and Marketing

6.1 Shared technologies

6.2 Different goals: data vs. emotion

6.3 Different competencies

Knowledge focus

- Compare use of drones in two sectors.
- Identify competencies needed for each.
- Understand dual use of UAVs.

Hands-on Activity

- Fill in a comparison chart - Create a profile of a UAV analyst vs. visual creator.

7. Comparison of UAV Use in Agriculture and Marketing

7.1 Shared technologies

7.2 Different goals: data vs. emotion

7.3 Different competencies

Knowledge focus

- Compare use of drones in two sectors.

- Identify competencies needed for each.
- Understand dual use of UAVs.

Hands-on Activity

- Fill in a comparison chart.
- Create a profile of a UAV analyst vs. visual creator.
- Design an NDVI mission and present results.
- Record and edit a promo video.
- Reflect on ethical cases in UAV use.

5.2 Module 2: Using UAVs for Precision Agriculture

Skills focus
Professional communication Information gathering Information analysis Critical thinking Decision-making Troubleshooting Innovation and adaptability Collaboration and teamwork Technical explanation Evaluation and comparison

Language focus
Use of technical vocabulary Understanding of professional terminology and jargon Classification and categorization of information Accurate reporting and interpretation of information Ability to objectively describe UAV applications in agriculture Differentiation of UAV types and functions Explanation of UAV operation principles Evaluation of agricultural interventions using UAV data Understanding UAV terminology related to precision agriculture Effective communication of technical content (listening, speaking, writing, presenting)

1. Introduction - UAV, drone

1.1 History

1.2 Terms, abbreviations, definitions

1.3 Basic principles of UAV operation and their use in agriculture

1.4 Differences between the main types of drones used in agriculture (multicopter , fixed-wing drone)

1.5 Advantages and disadvantages of drones

1.6 Safe operation

Knowledge focus

- Explain the history of its creation.
- Name the parts and explain the meaning of abbreviations.
- Basic principles of flight and control of unmanned aerial vehicles (UAVs).
- Possibilities of using UAVs in agriculture (crop monitoring, data collection, decision support).
- The importance of UAVs in the precision agriculture system.
- Characteristics of the main types of UAVs used in agriculture.
- Advantages and limitations of multicopters and fixed-wing drones.
- Suitability of individual types of UAV for various agricultural tasks.

Hands-on Activity

- Write a paper on history.
- Design a mind map of security requirements.
- Demonstration of the use of UAVs in various areas of agriculture (video, presentation, practical examples).
- Discussion on the benefits of UAVs for modern agriculture.
- Demonstration of different types of UAVs (real or through materials).
- Comparison of the use of a multicopter and a fixed-wing drone on specific examples from agriculture.

2. The use of navigation systems in precision agriculture

2.1 Technological accuracy of work operations

2.2 The origins of machine navigation

Knowledge focus

- Describe the optimal use of the machine's performance potential.
- Explain the burden on the operator of tasks related to maintaining the correct direction of travel of the machine set.

Hands-on Activity

- Explain the essential tasks associated with the control and correct adjustment of aggregate work tools.

3. UAV construction

3.1 Drone hood and cover

3.2 Chassis,

3.3 Arms, propellers and airfoils (wings)

3.4 UAV airfoils and wing mechanism

3.5 Engines

3.6 Control unit

3.7 Batteries and chargers

3.8 Stabilizer/ gimbal

3.9 GPS, GPS monitoring

3.10 Software and accessories

3.11 Practical exercise

Knowledge focus

- Distinguish the design differences between a multicopter and a fixed-wing drone.
- Understand the importance of airfoils and aerodynamics in a fixed-wing UAV.
- Describe the individual parts of drones.
- Explain the mechanics of individual parts.
- Understand the importance of data collection, processing and evaluation by the control unit.
- Describe monitoring, software, accessories.
- Discuss the individual parts.

Hands-on Activity

- Analyze individual parts from an assembly perspective
- Explain the function of the control unit, the principle of operation of GPS,
- Practically demonstrate the construction of a multicopter and a fixed-wing drone ,
- Explain the UAV wing mechanism and its critical nodes,
- Compare design solutions of different types of UAVs
- Show how to connect and charge batteries

4. Machine set control

4.1 Manual control

4.2 Assisted steering

4.3 Automatic control

Knowledge focus

- Understand the basic methods of controlling agricultural machinery.
- Describe mechanical control methods.
- Explain fluid control methods for aggregate devices.

- Explore automated ways to control mobile energy resources.
- Discuss the use of autonomous devices in primary agricultural production.

Hands-on Activity

- Write a two-page paper on the history of agriculture.
- Design a poster highlighting the importance of precision agriculture.
- Create a flowchart explaining the basics of automated control of mechanized means of transportation.
- Explain how autonomous machines work.

5. Machine set navigation

5.1 Flight log and flying

5.2 Maps/topography

5.3 Identification of take-off location/ MamDron

5.4 Practical exercise

5.5 Navigation using tramlines

5.6 Navigation using markers

5.7 Navigation using sensors

5.8 Navigation using GNSS

Knowledge focus

- Clarify the creation of a diary, the sequence of creating maps.
- Explain the content of the 3D map, important points for the flight.
- Explain the difference between machine tool control and machine and tool navigation.
- Describe the formation of tramlines during sowing.
- Characterize mechanical and foam markers.
- Explore optical, laser, and ultrasonic sensors.
- Explain the use of mechanical crop row feeler.
- Discuss the use of global navigation satellite systems.
- Create a calibration report.
- Verify the creation of a map and flight points in practice.

Hands-on Activity

- Design a poster explaining the difference between steering and navigating a machine tool.
- Write a paper on the use of markers in soil cultivation and the method of creating

tramlines when sowing.

- Discuss practical experiences with GNSS (GLONASS, GALILEO, BEIDOU).

6. Navigation systems in practice

6.1 System for switching off and on working sections

6.2 Selective control of tractor and implement

6.3 Dronestagram UAV

6.4 Application mapping (Drones for irrigation, Plant protection with drones, Legislation – spraying plants, Imaging drones, drone analysis use of GIS technologies, Harvest application, silage maps, Vegetation, yield, application maps)

6.5 Combinations of GNSS and LPS navigation systems

6.6 Combination of GNSS and tractor headland management

6.7 Automatic control of machines in a group

6.8 Complete UAV solution for animal husbandry

Knowledge focus

- Explain the use of navigation systems in agricultural production.
- Define a system for turning sections on and off when applying pesticides.
- Characterize the method of tool guidance using a separate GNSS antenna on an aggregated tool.
- Clarify the meaning of Dronestagram.
- Understand the application of OS Harvest in the field.
- Explain the creation and significance of maps for individual vegetation types.
- Describe additional control of the direction of movement of the aggregate tool.
- allow the use of less product, which translates into economic savings and a lower environmental impact.
- Describe the sensors in imaging.
- Explain the use of a combination of GNSS and sensor navigation (LPS - Local Positioning System).
- The importance of the registry for reproduction and business purposes.
- Control the movement of animals for protection purposes.
- Monitor animal behaviour on pastures.
- Prepare to perform complex tasks without constant human supervision, using AI.

Hands-on Activity

- Write a paper on the use of navigation systems in soil cultivation, sowing and plant care

during the growing season.

- Discuss the practical use of section switching when spraying.
- Explain the difference between passive and active guidance of aggregated work tools.
- Find a similar group to discuss your topic.
- Design a poster explaining the essence of using automatic machine control in a group for basic soil cultivation.
- Create videos of irrigation, spraying, and cattle grazing.
- Create a file from the registries for the given area.
- Take photos of the crisis area or grazing situation.
- Perform regular flights, allowing for continuous monitoring of crop health, detecting subtle changes that could indicate emerging problems and graphically capturing them in a graph.

7. Technology of controlled movement of machines in the field CTF - Controlled Traffic Farming

7.1 Technology of controlled movement of machines in the field CTF - Controlled Traffic Farming.

Knowledge focus

- Explain the essence of controlled movement of machines in the field from the perspective of a comprehensive soil compaction prevention system.
- Describe the use of uniform tracks in relation to the alignment of machine footprints and wheel gauges.

Hands-on Activity

- Discuss practical experiences with controlled movement of machines in the field.
- Explain the essence of matching the wheel tracks of mechanized means and the working width of the equipment used.

8. Machine movement monitoring and telematics

8.1 Technological accuracy of work operations

8.2 The origins of machine navigation

Knowledge focus

- Describe the methods of locating the machine on the plot.
- Explain the difference between the older OFF LINE information collection and the current ONLINE processing of information about machine movement and current operating parameters.
- Explain the essence of maintaining the working width from the perspective of fuel consumption.

Hands-on Activity

- Design a poster explaining the monitoring of machine movement in the field and the transfer of information from the machine to the management workstation.
- Discuss practical experiences with the localization of agricultural mechanization equipment.

9. Monitoring of vegetation development

9.1 Application maps (mowing, interventions)

9.2 Fertilizer application based on crop analysis

9.3 Evaluating the effectiveness of UAV interventions

9.4 Connected farm management (using UAV data)

Knowledge focus

- Using data obtained using UAVs and sensors as a basis for crop analysis and management of agricultural processes.
- The importance of repeated monitoring of stands after the intervention.
- Comparison of the condition of the vegetation before and after application.
- Explain the essence of spectroscopic analysis of various components in harvested crops.
- Characterize a thorough analysis of the work efficiency and variability of soil blocks.

Hands-on Activity

- Discuss ways to obtain information through a collection lab.
- Working with sample application maps (mowing, fertilizing).
- Discussion on the use of UAV data in farm management.
- Comparison of application and vegetation maps before and after the intervention.
- Discussion on further action based on monitoring results.
- Design an effective way to make the obtained data accessible.

10. Agri vision of meadows and pastures UAV

10.1 ARA sprayer for weeds only

10.2 Helicopter Spraying Drone

10.3 Map server

10.4 RC reconnaissance helicopter

10.5 Protecting wildlife when mowing

10.6 Drones for forest/bark

10.7 Drone for forest restoration after fires

10.8 Detecting water stress in plants

10.9 Scanning temperature varieties - experiment

Knowledge focus

- Assess a more appropriate means of spraying application.
- Evaluate the importance of a central map registry.
- Compare individual types.
- RC helicopters suitable for individual operations.
- Assess the suitability of protection by introducing robotic drones.
- Evaluate the affected areas based on shadows and detections.

Hands-on Activity

- Design a graph explaining the monitoring of machine movement in the field and the transfer of information from the machine to the management workstation.

6 Course 6: Legislation and licensing

6.1 Module 1 – Legislation and Licenses

Skills focus	Language focus
Communication Troubleshooting Data analysis Working with text Recording data	Technical terms related to drone legislation, Key terminology in the registration and registration of drones, Aviation terminology, Classify and categorize, Technical vocabulary, Identify flight limitations

1. Basics of Legislation

1.1 EU drone legislation overview

1.2 Aviation Act

Knowledge focus

- Familiarize yourself with the current rules and regulations regarding the operation of drones.
- Understand the basics of regulations and laws.
- Identify responsible UAV usage

Hands-on Activity

- Role-play: explain drone use to a local authority.
- Complete ethical UAV operator checklist.
- Look for changes in legislation focused on drones.

2. Legislative regulation

2.1 Distribution of unmanned devices (drones)

2.2 Restrictions about flying drones

Knowledge focus

- Describe the basic division of drones
- Define restrictions on flying drones

Hands-on Activity

- Draw a diagram of the basic distribution of drones according to the legislation in the Slovak Republic
- Create a list of potential restrictions for working with drones.

3. Registration

3.1 Drone Operators

3.2 Drone records

3.3 Regulation of drones, Drone user training and testing (Traffic Office)

Knowledge focus

- Control operator registration policies.
- Explain the conditions of drone registration and regulation .
- Describe how it is possible to obtain permission to fly a drone.

Hands-on Activity

- Describe the conditions of drone operator registration.
- Write a 2-page report focusing on the topic "What do I need to control when I want to use a drone for agricultural purposes”

4. Safety rules

4.1 Safety rules

4.2 Principles of safe flying

4.3 . Insurance

Knowledge focus

- Define elementary security rules.
- Explain the principles of safe flying.
- Define the basic forms of drone insurance.

Hands-on Activity

- Prepare a report about the safety rules for operating drones.
- Describe the reasons for safe flying.
- Process a table about individual types of drone insurance.