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Curriculum for unmanned aircraft vehicle operation competition

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Contents

Foreword

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Curriculum for unmanned aircraft vehicle operation competition

1 Scope

This document specifies the skill requirements, safety regulations, assessment proportion and performance evaluation of BRICS unmanned aircraft vehicle operation events.
This document is applicable to the holding and organization of BRICS unmanned aircraft vehicle operation competition and training, and also serves as the basis for skills passport base construction and international cooperation.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
unmanned aircraft vehicle;UAV
aircraft managed by the control station (including remote control or autonomous flight), including fixed-wing UAV, UAV helicopter, multi-rotor UAV

3.2
UAV system
system consisting of UAVs, associated control stations, required command and control data links, and any other components specified in the approved model design

3.3
UAV operation
operate and control the UAV system to complete the given flight mission, and be responsible for the operation and safety of the entire UAV system

3.4
fixed wing UAV
power-driven, air-heavy UAV whose flight lift is produced primarily by the airfoil that remains unchanged under a given flight condition

3.5
unmanned helicopter
heavier than air unmanned aircraft vehicle whose flight lift is mainly generated by one or more power-driven rotors on the vertical axis, and its movement state change is generally achieved by changing the rotor blade angle

3.6
multi-rotor UAV
UAV heavier than air, its flight lift is mainly generated by multiple power-driven rotors, and its movement state change control is generally realized by changing the rotor speed

3.7
run within visual range
operation of a UAV within the range where the pilot maintains direct visual contact, with a horizontal radius of no more than 500 meters and a relative altitude of no more than 120 meters

3.8
running beyond visual range
operations conducted by UAVs other than those within line of sight

4 Curriculum overview

4.1 Typical job task description

4.1.1 Installation, commissioning, and maintenance of UAV

4.1.1.1 Job task description

As a core application in the field of modern aviation technology, the installation, commissioning, and maintenance of UAVs play an irreplaceable role in ensuring the safety of enterprise operations and improving operational efficiency. The technical personnel responsible for the installation, commissioning, and maintenance of UAVs within the enterprise need to have a comprehensive understanding of the entire process of mechanical assembly, electrical assembly, system debugging, flight testing, and subsequent maintenance and damage assessment of UAVs. These technicians need to closely connect with business departments or customer needs, accurately complete the selection, personalized assembly, fine debugging, comprehensive testing, daily maintenance, and fault assessment of UAVs.

At the beginning of task execution, enterprise installation and maintenance personnel need to actively receive the UAV installation and maintenance task book from the business department, carefully study it to clarify the specific requirements, configuration details, and expected results of the task. Subsequently, they will carefully plan the work plan, coordinate the necessary tools, materials, and human resources, ensure that everything is ready, and strictly carry out operations in accordance with industry standards and enterprise norms for UAV installation, commissioning, and maintenance. This process involves precise assembly of the UAV, accurate connection of the electrical system, meticulous tuning of the flight control system, and multiple flight tests to verify performance.

Throughout the entire operation process, the installation, commissioning, and maintenance personnel of the enterprise must adhere to the bottom line of safety production and environmental protection, strictly comply with national laws, regulations, and industry norms, and actively refer to authoritative technical documents such as product manuals and maintenance manuals provided by UAV manufacturers to ensure that every operation is accurate and error free. After completing the UAV installation and maintenance tasks, the installation and maintenance personnel will conduct strict quality self inspection to ensure that the UAV performance reaches the optimal state, and then submit it to the business department for final acceptance. Professional maintenance and damage assessment services will be provided as needed to support the continuous operation and development of the enterprise.

4.1.1.2 Work Object

The human-machine installation and maintenance work includes five stages: task acquisition, plan formulation, task implementation, quality self inspection, and delivery acceptance. Each stage corresponds to different work objects, as shown in Table 1.

Table 1 Work Objects

NO.	Work Process	Work Object
1	Obtain the task	Receive the task book Obtain the workflow for UAV installation, commissioning, and maintenance Communicate with the business department to confirm the requirements
2	Draw up a plan	Clarify work objectives Analyze job responsibilities and required resources Develop detailed work steps Assign work tasks and time Develop a plan for UAV installation, commissioning, and maintenance work Submit to the business department for review and confirmation

Table 1 *(continued)*

NO.	Work Process	Work Object
3	Implementation of UAV installation, commissioning and maintenance tasks	Collect UAV components and tools according to the plan Mechanical and electrical assembly of UAVs Flight control system circuit connection and parameter debugging UAV flight testing and data recording Prepare a training report for UAV installation and adjustment
4	Quality Self Inspection	Conduct UAV flight performance testing Check the stability and safety of each system's operation Write a quality self inspection report
5	Delivery acceptance	Verify the UAV configuration and task book requirements Perform functional acceptance and flight demonstration Prepare the UAV maintenance acceptance form and sign it for delivery

4.1.1.3 Tools, materials, equipment, and data

The tools, materials, equipment, and materials required for UAV installation, commissioning, and maintenance work include five aspects: work task book, workflow, and product manual

a) Task acquisition process: work task book, unmanned aircraft vehicle installation and maintenance workflow, product manual, maintenance manual, compilation of relevant laws and regulations;
b) Planning process: work task book, UAV installation, commissioning and maintenance workflow, UAV assembly and commissioning process record form, work plan template;
c) UAV installation, debugging, and maintenance process: UAV components (such as body, motor, flight control board, remote control, etc.), specialized tools (such as screwdrivers, multimeters, soldering stations, testing software, etc.), protective equipment (such as anti-static wristbands, safety goggles), electrical connection materials (such as wires, connectors), debugging software, UAV simulation flight software, etc;
d) Quality self inspection process: testing software, UAV flight test record form, quality self inspection report template;
e) Delivery and acceptance process: acceptance form, summary report on UAV installation, commissioning, and maintenance.

4.1.1.4 Working methods

The working methods include five aspects: information retrieval, communication and coordination, analysis and summarization, and planning and layout

a) Task acquisition stage: information retrieval, communication and coordination;
b) Planning process: analysis and summarization, planning and layout;
c) UAV installation, debugging and maintenance process: observation method, measurement method, debugging method, simulated flight training method;
d) Quality self inspection process: observation method, testing and verification method, data analysis method;
e) Delivery acceptance process: on-site demonstration method, user feedback collection method.

4.1.1.5 Labor Organization Method

This work task is carried out through a combination of team collaboration and individual independent completion. During the task preparation and planning phase, the team can discuss and make decisions together; In the process of task implementation and quality self inspection, individuals independently complete operations and assume corresponding responsibilities; During the delivery and acceptance phase, the team collaborates to complete on-site demonstrations and user Q&A.

4.1.1.6 Job Requirements

The job requirements include six aspects: task acquisition, planning, and professional ethics requirements

a) Task acquisition process: Obtain the UAV installation, commissioning, and maintenance task book from the business department, specifying the specific content, objectives, and requirements of the task. Refer to the detailed workflow and technical standards for the installation, commissioning, and maintenance of UAV. Deeply communicate with business departments to ensure a comprehensive and accurate understanding of task requirements, laying the foundation for subsequent work;

b) Planning process: Based on the task book and communication with the business department, clarify the specific goals of UAV installation, commissioning, and maintenance work. Analyze the various stages of UAV installation, commissioning, and maintenance, including mechanical assembly, electrical assembly, system debugging, flight training, and maintenance and damage assessment, and develop detailed work plans. The specific content, required time, required resources, etc. of each step should be clearly defined in the plan, and a work plan should be prepared. Submit the work plan to the business department for review and confirmation, ensuring the rationality and feasibility of the plan;

c) UAV installation, commissioning, and maintenance process: During the task implementation, it is necessary to arrange the working environment reasonably to ensure safety and cleanliness; Standardize the use of tools and equipment to avoid damaging UAVs; Perform anti-static treatment to protect the electronic components of the UAV; Check the rated voltage before powering on to ensure safety; The cables are neatly tied and the screws are tightened to ensure the stability of the UAV structure; The installation of software must comply with relevant laws and regulations;

d) Quality self inspection process: Using observation and program testing methods, conduct a systematic inspection of the UAV to verify whether its operating status meets the requirements of the task book. The inspection includes but is not limited to the stability of mechanical structures, correctness of electrical system connections, stability of flight control systems, and compliance with flight performance standards. For the problems discovered, timely rectification is necessary to ensure that the performance of the UAV meets the standards;

e) Delivery acceptance stage: After passing the quality self inspection, the work site is organized according to the "5S" standard to ensure a clean and orderly environment. Submit the UAV and related documents (such as work plans, maintenance reports, etc.) to the business department for acceptance. During the acceptance process, it is necessary to demonstrate the performance of the UAV to the business department, answer questions, and ensure that the business department is satisfied with the installation, commissioning, and maintenance work of the UAV;

f) Professional ethics requirements: strictly abide by safety production and environmental protection regulations, and implement relevant laws and regulations; Prohibit the installation of non user licensed software on UAVs; Remind users to pay attention to UAV safety precautions; Protecting user privacy and data security; Actively learn new technologies and knowledge, enhance personal professional skills and service level.

4.1.1.7 Representative work tasks

Representative tasks for UAV installation, commissioning, and maintenance include multi rotor 450 UAV assembly project, UAV debugging and optimization, UAV maintenance, and UAV installation, commissioning, and maintenance teaching and training. Specific task descriptions are shown in table 2.

Table 2 Representative tasks for UAV installation, adjustment and maintenance

NO.	Task name	Task description	Time
1	Assembly project of 450 UAV for multi-rotor assembly and adjustment of a unit	In order to complete an assembly order of 40 multi-rotor 450 UAVs, a business department of a unit issued a task book (including a configuration list) to the assembly personnel. The assembly personnel were required to work at the customer's site to complete the UAV assembly task, and the acceptance of the business department was completed within seven days. The assembly personnel shall obtain the task book (including configuration list) from the business department, obtain the UAV assembly workflow, prepare the UAV assembly work plan, check the accessories according to the requirements of the task book, prepare tools, and assemble the UAV according to the work plan and workflow. After the assembly is completed, the assembled UAV and the assembly report shall be submitted to the responsible person of the technical department for review. Once the review is passed, the UAV will enter the subsequent commissioning stage and be ready for practical application.	8 hours
2	UAV Debugging and Optimization in a Scientific Research Institution	A scientific research institute has developed a new research UAV for aerial environmental monitoring. The technical department is responsible for the in-depth commissioning and optimization of the UAV. First of all, according to the specific needs of the scientific research mission, the flight control system of the UAV is subject to advanced settings, including precise adjustment of PID parameters, optimization of flight mode, etc. Then, UAV comprehensive performance test shall be carried out at professional test site, including takeoff and climb performance, hover stability, long-distance flight capability, etc., and detailed flight data shall be recorded. Based on the test data, the technical department will analyze the performance of the UAV in depth and optimize and adjust the power system and flight control system to improve the overall performance and stability of the UAV. At the same time, a safety assessment is conducted to ensure that the UAV still meets the relevant safety standards after optimization. Finally, the flight performance test and optimization report is prepared to provide strong support for the smooth implementation of scientific research missions.	8 hours
3	UAV maintenance in a forestry department	A forestry department has been using UAVs for forest resources monitoring and fire prevention patrol for a long time. In order to ensure that the UAV can continuously and stably perform the task, the technical department shall regularly organize the UAV maintenance work. Tasks include review of UAV troubleshooting techniques and preparation of necessary maintenance tools and spare parts. During maintenance, technicians will carry out comprehensive inspection on UAV, including wearing condition of mechanical parts, completeness of electrical circuit, health state of battery, etc. Technicians will quickly troubleshoot and repair any faults or potential problems found, such as replacing damaged propellers, repairing broken lines, and calibrating sensors. At the same time, fill in the detailed work record form and record the operation and results of each step of maintenance. Upon completion of the maintenance, the technician will perform a performance test of the UAV to verify that it returns to its optimum operating condition. Finally, the experiences of maintenance are summarized and shared, and the improvement measures are proposed, which can provide reference for the future maintenance of UAV.	8 hours

Table 2 *(continue)*

NO.	Task name	Task description	Time
4	Teaching Practice of UAV Installation, Debugging and Maintenance in Educational Institutions	An educational institution has set up a UAV installation, debugging and maintenance curriculum, aiming at cultivating professionals in the UAV field. The technical department is responsible for designing and implementing the training tasks of UAV installation, commissioning and maintenance teaching. The task includes formulating detailed teaching plan and training outline, covering multiple links such as UAV mechanical assembly, electrical installation, flight control system commissioning, maintenance and overhaul. In the training process, trainees will carry out the assembly and commissioning of UAV under the guidance of technical personnel, learn and master the basic skills and knowledge of UAV assembly, commissioning and maintenance. At the same time, set up the simulated fault and real case analysis link, so that the students can experience the process of troubleshooting and repair, and improve the ability to solve actual problems. Upon the completion of the training, the trainees shall prepare the training report, summarize the gains and shortcomings in the training process and put forward suggestions for improvement. The technical department will constantly optimize the teaching contents and methods according to the training results and feedback opinions to improve the teaching quality and effectiveness.	16 hours

4.1.2 UAV flight and maintenance

4.1.2.1 Job task description

UAV, as an important product of modern technology, are widely used in various fields such as aerial photography, agriculture, environmental monitoring, and rescue. Mastering flight and maintenance is a fundamental skill for becoming a qualified UAV operator or practitioner in related fields. The purpose of this job task is to systematically master the relevant terminology, classification, purpose, development history, flight principles, flight management, aviation meteorology, flight training, and maintenance of UAV, so that UAV operators or practitioners in related fields can fully familiarize themselves with UAV technology and possess the ability to apply and solve problems in practical work.

UAV flight or maintenance personnel need to receive specific task instructions regarding flight or maintenance, specifying detailed requirements and expected goals for flight or maintenance. Subsequently, in-depth study of technical documents and manuals related to UAVs was conducted to establish a solid theoretical foundation for subsequent work. During the operation phase, flight or maintenance personnel must strictly follow standard operating procedures. During this process, flight or maintenance personnel must strictly comply with operational standards and internal safety production and environmental management requirements of the enterprise, ensuring that flight and maintenance work is carried out in a safe and compliant environment. Throughout the entire workflow, personnel also need to actively practice the "5S" management concept, maintain a clean and orderly work area, in order to improve the efficiency and quality of operations.

4.1.2.2 Work object

The UAV flight and maintenance work includes five stages: task acquisition, planning, task implementation, quality self inspection, and delivery acceptance. Each stage corresponds to different work objects, as shown in table 3.

Table 3 Work objects

NO.	Work process	Work object
1	Obtain tasks	Collect work task book Understand the workflow and requirements Communicate with the project manager
2	Draw up a plan	Clarify work objectives and phased tasks Analyze job responsibilities Develop a detailed work plan Allocate work time Prepare a work plan Submit to the project manager for review
3	Task Implementation Assignment	Master the basic knowledge of UAV, flight principles, etc Practice and perform flight operations using a UAV simulator Study UAV application cases and understand their practical applications in work Participate in team discussions, share work experience, and work together to solve problems Participate in UAV maintenance tasks, learn troubleshooting and handling
4	Quality Self Inspection	Check the progress and quality of work according to the work plan and outline Verify flight operation skills and theoretical knowledge mastery through simulation testing Summarize the problems encountered during the work process and seek solutions
5	Delivery acceptance	Write a work summary report, including work results, problems, and solutions Accept the evaluation and acceptance of work results and abilities by the project manager or client Based on feedback, adjust the work plan to improve work efficiency

4.1.2.3 Tools, materials, equipment, and data

The tools, materials, equipment, and materials required for UAV flight and maintenance work include five aspects: work task book, work plan, work schedule, etc

a) Task acquisition process: work task book, outline, project manager contact information;
b) Planning process: work schedule, work progress chart, work notebook;
c) Task implementation homework: UAV basic knowledge manual, simulated flight software, UAV model, multimedia teaching equipment, network resources (online courses, technical forums, professional websites), practical tools (screwdriver, cleaning cloth, multimeter), etc;
d) Quality self inspection process: self-assessment form, simulation testing software, problem log book;
e) Delivery acceptance process: work report template, PPT production software, video recording equipment, project acceptance standards.

4.1.2.4 Working methods

The working methods include five aspects: information retrieval, communication and coordination, goal setting, and task decomposition

a) Task acquisition stage: information retrieval, communication and exchange;
b) Planning process: goal setting, task decomposition, time management;
c) Task implementation process: teaching method (self-study), discussion method, case analysis method, simulation operation method, practical exploration method;
d) Quality self inspection process: self reflection, simulation testing, problem organization;
e) Delivery acceptance process: Results display method, project evaluation method, feedback improvement method.

4.1.2.5 Labor Organization Method

This job task is carried out through a combination of self-learning and team collaboration, using various organizational forms such as classroom teaching, laboratory operations, group discussions, and project practices to enhance the learning effectiveness and comprehensive abilities of technical personnel. Encourage technical personnel to actively participate in work discussions, actively explore UAV technology, and enhance work skills and professional ethics.

4.1.2.6 Job Requirements

The job requirements include six aspects: task acquisition, planning, and professional ethics requirements.

a) Task acquisition process: Obtain task books from the business department, accurately understand the requirements of the work task book and outline, proactively communicate with the project manager, and clarify the key and difficult points of the work;
b) Planning process: Based on the task book and communication with the business department, set reasonable, specific, and actionable work goals to ensure that the plan is both challenging and measurable of progress. Thoroughly analyze the job content, arrange time reasonably, and ensure that the work progress closely matches the plan. Prepare a detailed work plan and submit it to the project manager for review to obtain valuable feedback and guidance. Maintain flexibility in the plan and make timely adjustments based on actual situations to ensure efficient progress of work;
c) Task implementation stage: Actively participate in learning and discussion according to the work plan, listen carefully and take notes, and comprehensively master the theoretical knowledge related to UAVs. Continuously improve flight operation skills through practical operations using simulated flight software and UAV models. Actively participate in case analysis and gain a deep understanding of the application scenarios and challenges of UAVs in practical work;
d) Quality self inspection process: Regularly conduct self-assessment to check whether the work progress and quality meet the standards. Use simulation testing software to verify flight operation skills and theoretical knowledge mastery, and promptly identify and correct problems. Carefully record the problems and solutions encountered during the work process, form a personal work file, and provide reference and inspiration for subsequent work;
e) Delivery acceptance stage: Carefully write a work report, comprehensively summarize the work results and experiences, and showcase one's own work achievements and gains. Carefully prepare the presentation materials to ensure that the content is clear, accurate, and persuasive. Humbly accept evaluations and feedback from project managers or clients, listen carefully to suggestions, and promptly improve shortcomings. Ensure timely completion of delivery tasks, submit high-quality work results, and gain customer recognition and satisfaction;
f) Professional ethics requirements: Possess a high level of professional ethics and conduct, comply with industry standards and regulations. Maintain an honest, dedicated, and responsible attitude in work, and establish a good professional image.

4.1.2.7 Representative work tasks

Representative tasks for UAV flight and maintenance include UAV selection and configuration planning, UAV flight performance testing and optimization, UAV environment monitoring task planning and execution, UAV competition strategy formulation and training, and UAV maintenance and troubleshooting. Specific task descriptions are shown in table 4.

Table 4 Representative tasks for UAV flight and maintenance

NO.	Task name	Task description	Time
1	Selection and configuration planning of an agricultural science and technology UAV	An agricultural technology company plans to introduce UAV for precision agricultural operations, such as crop monitoring, pesticide spraying, etc. The technical department shall select the most suitable model for agricultural application from various UAV models according to the specific needs of agricultural operations and combined with the classification and use of UAVs. Meanwhile, the UAV configuration is planned, including high-definition multi-spectral camera, intelligent spraying system and other task load systems, to meet the data acquisition and operation requirements of precision agriculture. Technical departments need to conduct detailed demand analysis, UAV selection, configuration planning and cost budget, and finally submit the scheme to management for approval, so as to ensure that the UAV solution meets agricultural operation requirements and is economical and efficient.	8 hours
2	UAV flight performance test and optimization project of an aerial photo company	An aerial photo company has purchased a batch of high-performance UAVs for film and television shooting. In order to ensure stable flight and high-quality image acquisition of UAV in complex shooting environment, technical department shall conduct comprehensive flight performance test on UAV in professional test site, including takeoff, climb, hover, high-speed flight and sharp turn, and record flight data. Based on Newton's law of motion and aerodynamic basis, the technical department will analyze the flight data in depth and optimize the UAV's power system and flight control system to improve the flight performance and stability. At the same time, a safety assessment is conducted to ensure that the UAV can still meet relevant laws, regulations and safety standards after optimization. Finally, the flight performance test and optimization report is prepared to provide reference for the follow-up film and television programs.	8 hours
3	Planning and Execution of UAV Environment Monitoring Task of an Environmental Protection Agency	An environmental agency plans to use UAVs for air quality monitoring and source tracking. The technical department shall select the appropriate UAV model according to the specific requirements of the monitoring task, and plan its configuration, including task load systems such as gas detector and HD camera. Prior to mission execution, technical departments need to study the effects of aeronautical meteorological conditions, in particular the three elements of the atmosphere (temperature, humidity, and pressure) on flight, and the effects of cloud cover and visibility on flight safety, in order to develop scientific and reasonable flight plans.- g. During execution, the UAV will collect data according to the predetermined route and transmit the monitoring data to the ground station in real time through the communication and navigation system. Upon the completion of the task, the technical department will organize and analyze the monitoring data to provide scientific basis for environmental protection decision-making.	8 hours
4	Strategy making and training of UAV competition in an UAV club	A UAV club prepares to participate in the international UAV racing competition, and the technical team shall formulate the UAV competition strategies and skills according to the competition rules and track characteristics. During the strategy development process, the team needs to further study the basic structure and performance of the UAV, especially the impact of flight control and power systems on the racing performance. At the same time, take into account aviation meteorological factors, such as wind speed, the influence of wind direction on flight route selection, and flight restrictions under extreme weather conditions to develop flexible competition strategies. During the training phase, the team members will simulate the competition environment, carry out high-intensity flight training, and improve the control skills and competition strategy execution ability of UAVs.	8 hours

Table 4 *(continued)*

NO.	Task name	Task description	Time
5	UAV maintenance and troubleshooting of a logistics company	A logistics company organized UAV maintenance and troubleshooting practice, and the technical department organized technical personnel to review the basic knowledge of UAV maintenance and troubleshooting skills. Technicians need to quickly review the basic knowledge of UAV maintenance and prepare necessary maintenance tools and spare parts. At the fault site, the technical department shall set up a simulated fault on the UAV. The technical personnel shall conduct troubleshooting and repair in groups, fill in the work record form and verify the performance of the UAV after repair. Summarize and share troubleshooting and repair experience and collect feedback after the drill, so as to provide improvement direction for future UAV maintenance.	8 hours

4.1.3 UAV control application

4.1.3.1 Job task description

The application tasks of UAV control cover the practical applications of UAVs in multiple fields, including aerial photography, crop protection, inspection, security, logistics, surveying, emergency rescue, and programming development. The technical personnel responsible for UAV control applications within the enterprise must possess comprehensive skills in UAV operation, task planning, on-site execution, and data processing and analysis. They need to work closely with business departments, develop detailed work plans based on specific task requirements, and ensure the safe and efficient operation of UAVs in various complex environments.

Enterprise UAV operators first need to receive a detailed UAV control application task book from the business department or customer, covering task types, specific goals, expected outcomes, and special requirements. Subsequently, the UAV operator will thoroughly study the task book and communicate multiple times with the business department or client to ensure a comprehensive and accurate understanding of the task requirements. This process may involve detailed discussions on UAV models, sensor configurations, flight routes, data collection requirements, and other aspects. After clarifying the task requirements, the UAV operator will proceed to develop a detailed work plan. To ensure the smooth progress of the task, the UAV operator also needs to carefully plan the work during the task preparation stage, actively coordinate with relevant departments or suppliers, and ensure that the required resources are in place in a timely manner.

During the task execution phase, enterprise UAV operators will strictly follow the work plan and UAV control specifications for operation. During the execution process, the UAV operator also needs to closely monitor the status of the UAV and the progress of the task, and make real-time adjustments based on the actual situation. In case of unexpected situations or abnormal data, it is necessary to respond quickly and take corresponding measures. After the task is completed, the enterprise UAV operator will conduct strict quality self inspection and analyze the problems and deficiencies that exist during the task execution process. Subsequently, the UAV operator will organize the task results and quality inspection reports, and submit them to the business department or customer for acceptance. At the same time, a summary and analysis will be conducted based on task execution and user feedback to extract lessons learned and provide improvement directions for future UAV control application tasks.

4.1.3.2 Work Object

The application work of UAV control includes five stages: task acquisition, plan formulation, task implementation, quality self inspection, and delivery acceptance. Each stage corresponds to different work objects, as shown in table 5.

Table 5 Work objects

NO.	Work process	Work object
1	Obtain tasks	Collect task book Clearly define the type of task (such as aerial photography, plant protection, inspection, etc.) and specific requirements Communicate with the business department to understand the background, goals, and expected outcomes of the task
2	Draw up a plan	Clarify work objectives based on task types Analyze job responsibilities and required resources Analyze the task execution environment, including factors such as terrain, climate, electromagnetic interference, etc Develop detailed work steps, schedules, and emergency plans Prepare a work plan, including flight plans, safety contingency plans, data recording requirements, etc Submit the work plan to the business department for review and confirmation
3	Task implementation	According to the work plan, prepare equipment and accessories such as UAVs, remote controls, sensors, batteries, etc Check the status of the UAV, perform necessary debugging and calibration Execute flight missions, including takeoff, cruise, photography/operations, landing, and other stages Real time monitoring of UAV status, adjusting flight parameters and operating modes according to requirements Record key data and information during task execution
4	Quality self inspection	Download and check flight data, shooting materials, or homework results Evaluate data quality, including clarity, completeness, accuracy, etc Perform necessary post-processing, such as image processing, data analysis, etc Verify whether the task results meet the task book and customer requirements
5	Delivery acceptance	Organize task results and create acceptance reports Communicate with business departments and clients, showcase task results, and listen to feedback Make necessary modifications and improvements based on feedback Sign and deliver task results, complete settlement

4.1.3.3 Tools, materials, equipment, and materials

The tools, materials, equipment, and materials required for UAV control applications include task books, technical guidelines, task planning tools, and other five aspects:

a) Task acquisition process: UAV control application task book, technical guidelines for various task areas, communication records with business departments, compilation of relevant laws and regulations;
b) Planning process: workflow of UAV control application, task planning tools (such as map software, route planning software), work plan template, weather forecast, safety plan template;
c) Implementation of UAV control application tasks: UAVs and their accessories (such as batteries, remote controls, sensors, chargers), specialized tools (such as screwdrivers, calibration boards), software platforms (such as UAV control software, programming development environment), protective equipment (such as helmets, protective clothing), data cables, storage cards, cameras, emergency rescue equipment, etc;
d) Quality self inspection process: testing software, data analysis tools, quality self inspection report templates;
e) Delivery acceptance process: task achievement report, presentation, acceptance form, customer

feedback form.

4.1.3.4 Working methods

The working methods include five aspects: information retrieval, communication and coordination, analysis and summarization, and planning and layout

a) Task acquisition stage: information retrieval, communication and coordination;
b) Planning process: analysis and summarization, planning and layout;
c) Implementation of UAV control application tasks: field investigation, UAV control technology, programming and development skills, data collection and recording;
d) Quality self inspection process: data analysis method, testing and verification method, problem diagnosis and resolution;
e) Delivery acceptance process: on-site demonstration method, user feedback collection method, report preparation and presentation.

4.1.3.5 Labor Organization Method

This job task is usually led by a UAV operator, and if necessary, a multifunctional team composed of operators, data analysts, technical support personnel, etc. can be formed to jointly complete the task.

4.1.3.6 Job Requirements

The job requirements include six aspects: task acquisition, planning, and professional ethics requirements

a) Task acquisition process: Obtain the UAV control application task book from the business department, accurately understand the task requirements, maintain good communication with the business department, and ensure the accuracy of task information;
b) Planning process: Based on the task book and communication with the business department, clarify the specific goals of the UAV control application task. Scientifically and reasonably formulate work plans, fully consider resource allocation and time management, and ensure efficient task execution;
c) Implementation of UAV control application tasks: During the task implementation process, strictly follow the operating procedures to ensure the safety of UAV control; Accurately execute tasks to ensure accurate data and clear images; For programming development tasks, it is necessary to follow the software development process to ensure code quality and functional implementation;
d) Quality self inspection process: Conduct quality inspections carefully, promptly identify and solve problems; Write a detailed quality self inspection report to provide reference for subsequent work;
e) Delivery acceptance stage: Organize the task results, communicate fully with the business department, and ensure smooth acceptance; Actively collect user feedback to provide a basis for future work improvement;
f) Professional ethics requirements: comply with safety operation and environmental protection regulations, protect user privacy and data security; Continuously learning new technologies and knowledge, improving personal professional skills and service levels.

4.1.3.7 Representative Work Tasks

Representative tasks of UAV control applications include panoramic aerial photography of urban scenery, precise crop protection of thousands of acres of farmland, autonomous inspection of transmission lines, UAV patrols, and rapid distribution of medical supplies. Specific task descriptions are shown in table 6.

Table 6 Representative tasks for UAV control applications

NO.	Task name	Task description	Time
1	Panoramic aerial photography project of urban scenery of an advertising company	In order to capture the unique scenery of the city and improve the visual impact of the city image promotion film, an advertising company undertook a panoramic aerial photography project. The technical department first develops detailed aerial photography mission planning	8 hours

Table 6 *(continued)*

NO.	Task name	Task description	Time
2	Precise plant protection for thousands of mu farmland of an agricultural cooperative	In order to improve the yield and quality of crops and reduce the environmental pollution caused by the use of pesticides, an agricultural cooperative decided to use UAVs for precise plant protection operations. The technical department shall first formulate detailed plant protection task planning according to the geographical location of farmland, crop types, growth cycle and pest and disease conditions, including the selection and proportion of agent, calculation of spraying amount, setting of flight height and speed, etc. In the task preparation stage, the technical team shall conduct comprehensive inspection and commissioning on the UAV plant protection equipment to ensure that the equipment is in the best working state. At the same time, reasonable flight routes shall be planned according to the layout of farmland to ensure that the plant protection operation is fully covered without omission. During the mission, the UAV flies at low altitude over the farmland according to the preset flight route to accurately spray pesticides. The technical team monitors the flight status and spraying effect through the ground station, and timely adjusts the flight parameters to ensure the accuracy and efficiency of plant protection operation. Upon completion of plant protection, technicians will analyze the collected data to evaluate the plant protection effect and provide reference for subsequent operations.	8 hours
3	Self-inspection of transmission line of an electric power company	In order to ensure the safe and stable operation of the transmission line and improve the inspection efficiency, an electric power company plans to use UAVs for independent inspection. The technical department shall first formulate detailed patrol task planning and flight route according to the distribution of power transmission lines, terrain characteristics and patrol requirements. Such detection equipment as HD camera and infrared thermal imager carried by UAV shall be used to conduct comprehensive and multi-angle patrol inspection on transmission line. In the mission preparation phase, the technical team will debug and calibrate the UAV patrol inspection equipment to ensure that the inspection equipment can accurately capture the defects and hidden dangers of the transmission line. Meanwhile, reasonable flight height and speed shall be planned according to the characteristics of patrol area to ensure the comprehensiveness and accuracy of patrol inspection. During the mission execution, the UAV flies independently according to the preset flight route and conducts patrol inspection on the power transmission line. The technical team monitors the flight status and patrol inspection data in real time through the ground station, and timely finds and records the defects and hidden dangers of the transmission line. Upon the completion of patrol inspection, analyze and process the collected data to form a patrol inspection report, so as to provide strong support for the maintenance and overhaul work of the power company.	8 hours

Table 6 *(continued)*

NO.	Task name	Task description	Time
4	Security UAV patrol for large-scale activities in a city	In order to ensure the safety and order of the activity site, the public security department decided to use UAVs to patrol high above the ground in a city where a large event is going to be held.g. The technical department shall formulate detailed patrol task planning and flight route according to the activity area, passenger flow distribution, safety risk point and other factors. During the mission preparation phase, the technical team conducts a comprehensive inspection and commissioning of UAV patrol equipment to ensure that the equipment can operate stably and meet the patrol requirements. At the same time, communicate and coordinate with the event sponsor to ensure the smooth implementation of the patrol plan. During mission execution, the UAV carries out high-altitude patrol according to the preset flight route to monitor the activity site in an all-round way without dead angle. The technical team monitors the flight status and video images through the ground station in real time, and detects and reports abnormal conditions in time. The collected video data will be analyzed and processed after the patrol to provide strong support for the decision-making of the public security department.	8 hours
5	Quick distribution of medical supplies in a remote mountainous area	Due to inconvenient transportation in a remote mountainous area, it is difficult to transport medical supplies. To improve the medical conditions of mountain residents, logistics companies decided to use UAVs for fast distribution. The technical department shall prepare detailed distribution task planning and flight route according to mountainous terrain, climate conditions, material demand and other factors. In the task preparation stage, the technical team carries out adaptive transformation and commissioning on the UAV distribution equipment to ensure that the equipment can operate stably in complex environment. At the same time, sufficient medical supplies shall be prepared and packaged and fixed on the UAV. During the mission, the UAV passes through the mountainous area according to the preset flight route to quickly deliver the medical supplies to the designated place. The technical team monitors the flight status and material distribution through the ground station in real time to ensure the accuracy and timeliness of distribution. Upon the completion of distribution, analyze and process the collected data, evaluate the distribution effect and provide reference for subsequent distribution.	8 hours

4.2 Course positioning

The audience of this course is individuals who are interested in developing in the field of UAVs.

This course can effectively reflect the characteristics and training objectives of vocational education. When studying this course, through systematic training and project-based practical training, participants can acquire professional skills in the field of UAVs in a relatively short period of time, which plays a supporting role in the cultivation of students' professional abilities and professional qualities. Meanwhile, this course can serve as a pre exam training standard for UAV skills passport. And it can further lay a solid foundation for the BRICS Vocational Skills Competition.

The UAV operation course is designed based on the UAV vocational skill standards, aiming to cultivate students' mastery of the basic theory, operational skills, and safety regulations related to UAV technology. Through the study of this course, students should be able to understand the working principles of UAVs, proficiently operate various UAV systems, possess the ability to solve practical problems, and pay attention to the cultivation of safety flight awareness, laying a solid foundation for the widespread application of UAVs in fields such as aerial photography, agriculture, surveying, and rescue. This course comprehensively covers all aspects of UAV technology, aiming to provide students with a comprehensive and in-depth UAV learning experience.

5 Curriculum objectives

5.1 Goal overview

The curriculum objective of BRICS National Vocational Skills Competition UAV Operation is to build a systematic and comprehensive content system, which deeply integrates the dual training of theoretical knowledge and practical skills, and particularly emphasizes the building of key abilities such as project management and team cooperation, so as to comprehensively improve the professional quality of students in UAV operation and application fields.

5.2 Knowledge objectives

The knowledge objectives of the UAV operation course in the BRICS Vocational Skills Competition include the following 42 items:

——The cutting-edge international trends in UAV technology, with a deep understanding of the latest developments in UAV technology;
——Scoring criteria and evaluation points for different competition tasks;
——The basic concepts and classifications of UAVs, including common types such as multi rotor, fixed wing, and unmanned helicopters;
——The application scenarios of UAVs in different fields, such as aerial photography, crop protection, logistics, etc;
——The development history of UAVs, including important technological breakthroughs and milestone events;
——Basic strategies and techniques for UAV competitions, improving UAV control skills;
——The application of Newton's laws of motion in UAV flight, including inertia law, acceleration law, etc;
——Basic knowledge of aerodynamics, such as hydrostatics, fluid dynamics, lift and drag, etc;
——The flight principle of UAVs, including lift generation, flight stability control, etc;
——The flight performance parameters of UAVs, such as maximum speed, climb rate, range, etc;
——The basic structural components of a UAV include the fuselage, wings, tail wing, landing gear, and other parts;
——The composition and working principle of the UAV power system, including motors, batteries, propellers, etc;
——The functions and operation methods of the UAV ground station system, including remote monitoring, data transmission, etc;
——The composition and principle of UAV flight control system, including sensors, flight control board, control algorithms, etc;
——The working principle of UAV communication and navigation system, including GPS positioning, wireless communication, etc;
——Types and applications of UAV mission payload systems, such as cameras, LiDAR, infrared sensors, etc;
——Relevant knowledge of airspace management, including airspace division, flight permit application, etc;
——Regulations on the management of UAVs, including registration, insurance, flight reporting, and other processes;
——Management requirements for UAV operators, including qualification certification, training and assessment, etc;
——Laws and regulations related to UAV flight to ensure legal and compliant flight;
——Basic knowledge of the atmosphere, including its composition, structure, temperature distribution, etc;
——The formation, classification, and impact on flight safety of clouds enhance flight decision-making capabilities;
——The impact of different weather phenomena on UAV flight, such as wind shear, turbulence, etc;
——Flight strategies and response measures for UAVs in adverse weather conditions;
——Methods for collecting and analyzing meteorological information before UAV flight;
——Meteorological monitoring and emergency response procedures during UAV flight;
——Methods for recording and managing UAV flight logs;
——Basic knowledge and skills of UAV maintenance and upkeep;
——Methods for diagnosing and troubleshooting UAV malfunctions;
——Techniques for selecting and replacing UAV accessories;
——The flight characteristics and limitations of UAVs in different terrains and environments;
——The principle and technology of UAV formation flight;

——Application cases and technical requirements of UAVs in agriculture, forestry, surveying and other fields;
——The prospect of combining UAVs with technologies such as artificial intelligence and big data;
——Methods for UAV flight safety and risk assessment;
——The potential application of UAVs in emergency rescue, environmental monitoring, and other fields;
——The development trend and future direction of the UAV industry;
——Methods for debugging UAV software and upgrading firmware;
——The importance of UAV battery management and charging technology;
——Software tools for UAV data processing and analysis;
——Methods and rules for collaborative operations between UAVs and other aircraft;
——The flight skills and emergency response capabilities of UAVs in complex environments.

5.3 Skill objectives

The skill objectives of the UAV operation course in the BRICS Vocational Skills Competition include the following:

——Can explain UAV related terms such as "multi rotor", "fixed wing", "unmanned helicopter", etc;
——Capable of distinguishing different types of UAVs, including multi rotor UAVs, fixed wing UAVs, unmanned helicopters, etc;
——Can describe the various uses of UAVs, such as aerial photography, agricultural spraying, environmental monitoring, etc;
——Can provide an overview of the development history of UAVs, including key events and technological advancements;
——Ability to analyze strategies for UAV competitions, including flight path planning, speed control, etc;
——Being able to apply Newton's laws of motion to explain the basic flight principles of UAVs;
——Can explain basic knowledge of aerodynamics, such as lift, drag, etc;
——Capable of analyzing the flight performance parameters of UAVs, such as maximum flight speed, climb rate, etc;
——Being able to identify and explain the basic structural components of UAVs, such as the body, wings, tail fins, etc;
——Can explain the working principle of the UAV power system, including the motor, battery, and ESC, etc;
——Can describe the functions of the UAV ground station system, such as remote control, data transmission, etc;
——Can explain the architecture and working principle of the UAV flight control system;
——Can explain the composition and functions of UAV communication and navigation systems;
——Capable of analyzing the types and applications of UAV mission payload systems;
——Can explain the basic concepts and principles of airspace management;
——Capable of registering, registering, and reporting UAVs;
——Can explain the professional qualification requirements and management regulations for UAV operators;
——Can explain laws and regulations related to UAVs, such as the Civil Aviation Law of the People's Republic of China and the Regulations on the Management of UAVs;
——Can describe the basic composition and characteristics of the atmosphere, such as temperature, humidity, pressure, etc;
——Being able to identify different types of clouds and understand their impact on flight;
——Capable of using UAV related tools and equipment for simple assembly and disassembly;
——Ability to use UAV debugging software for basic parameter settings and adjustments;
——Capable of selecting the configuration of the flight platform based on the requirements of UAV flight missions;
——Capable of independently completing daily maintenance and upkeep tasks for UAVs, such as cleaning, lubrication, fastening, etc;
——Capable of using testing equipment to perform functional testing on components and systems of UAVs;
——Capable of diagnosing and analyzing faults in UAV components based on their symptoms;
——Capable of replacing or repairing faulty components of UAVs based on fault diagnosis results;
——Capable of writing detailed reports on the assembly, testing, and maintenance of UAV components;
——Capable of conducting safety checks before UAV takeoff and after landing;
——Capable of configuring and selecting suitable UAV mission payload systems based on task requirements;
——Capable of using UAV communication devices for data transmission and instruction reception;
——Ability to adjust the flight mode and parameter settings of the UAV according to the flight environment;

——Capable of using UAV navigation systems for precise flight positioning and route planning;
——Capable of handling unexpected situations encountered by UAVs during flight, such as obstacle avoidance, loss of control, etc;
——Ability to assess the flight risks of UAVs and take corresponding safety measures based on weather and meteorological conditions;
——Capable of writing detailed plans and execution strategies for UAV flight missions;
——Capable of conducting virtual flight operations and flight simulations in complex environments through UAV flight simulation software;
——Capable of planning and executing flight tasks in UAV flight simulation software according to task requirements;
——Capable of basic UAV control, including takeoff, landing, level flight, turning, etc;
——Being able to participate in the collaboration of UAV teams and jointly complete complex flight tasks;
——Being able to accept and understand new technologies and knowledge in the UAV industry, continuously improving one's skill level;
——Be able to comply with the professional ethics and conduct of the UAV industry, ensuring work quality and safety;
——Be able to participate in the development and improvement of UAVs, and provide constructive opinions and suggestions.

5.4 Literacy objective

The literacy objectives of the UAV operation course in the BRICS Vocational Skills Competition include the following:

a) Having an innovative mindset that breaks away from traditional thinking patterns, dares to challenge the status quo, and proposes new perspectives and ideas;
b) The ability to combine theoretical knowledge with practical operation, and to quickly analyze, evaluate, and select appropriate solutions when facing problems;
c) Having an open mind to accept opinions and suggestions from others, possessing team spirit and communication skills with others;
d) Develop the habit of self-directed learning, possess critical thinking skills, be able to think independently, analyze problems, and make judgments;
e) Have time management awareness and the ability to develop detailed work plans;
f) Having professional ethics and a sense of social responsibility, cultivating a professional awareness of complying with laws, regulations, and industry standards, and not harming public interests and the safety of others.

6 Curriculum content

6.1 Basic theory

The basic theory includes six aspects: overview of UAVs, basic structure and functional systems of UAVs, flight principles, flight management, basic knowledge of installation, commissioning and maintenance, and aviation meteorology:

a) Overview of UAVs;
b) Basic structure and functional system of UAVs;
c) Principles of UAV flight;
d) UAV flight management;
e) Overview of basic knowledge of UAV installation, commissioning, and maintenance;
f) Aviation meteorology.

6.2 Skill practice

The learning tasks of UAV installation, commissioning, and maintenance skills practice include the basic structure and functional system of UAVs, basic knowledge of UAV installation, commissioning, and maintenance, selection of UAV functional systems, UAV assembly and commissioning, UAV flight training, and UAV maintenance and damage assessment. Specific learning objectives and skill points are shown in table 7.

Table 7 Learning task of UAV installation, commissioning and maintenance

No.	Learning task name	Teaching hour	Learning target	Skill point
1	Basic structure and function system of UAV	14	Master the structure and system of common UAVs	Master the basic structure of UAV Master the power system of UAV Master the UAV ground station system Master UAV flight control system Master UAV communication and navigation system Master UAV task load system
2	Overview of basic knowledge of UAV assembly, debugging and maintenance	10	Understand and master basic knowledge of UAV assembly, commissioning and maintenance	Master the basic knowledge of UAV mechanical assembly Master the basic knowledge of electrical assembly and adjustment Master the basic knowledge of information technology Understand the basic knowledge of safety production and environmental protection Understand relevant laws and regulations
3	Selection of UAV functional system	14	Can perform correctly selection of UAV functional system	Aircraft platform configuration selection Layout structure selection Material selection Selection of power system Selection of flight control and navigation system Communication system selection Selection of takeoff and landing system Selection of task load system
4	UAV assembly and commissioning	18	Capable of completing the specified model assembly and commissioning of UAV	Multi-rotor UAV welding technology Assembly of UAV Body for Commissioning Training Flight control line connection and remote controller setting Commissioning and calibration of flight control parameters UAV flight test Prepare report form
5	UAV flight training	14	Master of UAV simulation flight and conventional flight control	UAV simulation flight UAV flight control
6	UAV maintenance and damage determination	16	Capable of UAV maintenance and damage determination	Overview of UAV maintenance and damage determination Performance and detection methods of common faults UAV troubleshooting Prepare maintenance report
Note			86 class hours in total	

The learning tasks for UAV flight and maintenance skills practice include UAV overview, UAV flight principles, UAV flight management, aviation meteorology, UAV flight training, and UAV maintenance. Specific learning objectives and skill points are shown in table 8.

Table 8 UAV flight and maintenance learning tasks

No.	Learning task name	Teaching hour	Learning target	Skill point
1	Overview of UAV	8	Master the basic knowledge of UAV application and development history	Explanation of UAV-related terms Classification of UAVs Common applications of UAVs Understand the history of UAV development Master UAV competition strategies and skills
2	UAV Flight Philosophy	14	Master the flight principle of UAV	Master Newton's law of motion Basic understanding of aerodynamics Understand flight principles Flight Performance Awareness
3	UAV Flight Management	10	Master relevant UAV laws and regulations	Airspace management Management of UAV UAV operator management Understand laws and regulations related to UAV
4	Aviation meteorology	10	Get familiar with the influence of meteorological conditions on flight	Master the basic knowledge of atmosphere Impact of cloud on flight safety Impact of Visibility on Flight Safety Influence of three elements of atmosphere on flight Flight restrictions under extreme weather conditions
5	UAV flight training	12	Master of UAV Simulation flight and conventional flight control	UAV simulation flight UAV flight control
6	Maintenance of UAV	10	Capable of maintenance of common UAVs	Master the basic knowledge of UAV maintenance Master the maintenance of UAV parts Troubleshooting of UAV Routine maintenance of UAV
Note	64 class hours in total			

The learning tasks for practical application skills in UAV control should include UAV aerial photography, UAV crop protection, UAV inspection, UAV security, UAV logistics, UAV surveying, UAV emergency rescue, and UAV programming development. Specific learning objectives and skill points are shown in table 9.

Table 9 Learning tasks of UAV control application

No.	Learning task name	Teaching hour	Learning target	Skill point
1	UAV aerial photography operation	8	Be able to independently complete the designated UAV aerial photography task	UAV aerial photography operation planning and formulation Preparations for UAV aerial photography Completion of UAV aerial photography task
2	UAV plant protection operation	8	Capable of independently completing specified UAV plant protection task	Development of UAV plant protection operation planning Preparations for UAV plant protection Completion of UAV plant protection task

Table 9 *(continued)*

No.	Learning task name	Teaching hour	Learning target	Skill point
3	UAV patrol inspection	8	Capable of independently completing specified UAV patrol inspection task	Preparation of UAV patrol inspection plan Preparations for UAV patrol inspection Complete UAV patrol inspection task
4	UAV security operation	8	Capable of independently completing specified UAV security task	Formulation of Man-machine Security Operation Planning Preparations for man-machine security work Complete UAV security tasks
5	UAV Logistics Operations	8	Capable of independently completing specified UAV Logistics Tasks	Formulation of UAV logistics operation planning Preparations for UAV Logistics Operation Complete UAV logistics tasks
6	UAV surveying and mapping operation	8	Capable of independently completing specified UAV Mapping Mission	Preparations for UAV surveying and mapping UAV surveying and mapping data acquisition UAV surveying and mapping data processing and task completion
7	UAV emergency rescue	8	Capable of independently completing specified UAV rescue task	UAV personnel search and rescue UAV material distribution
8	UAV programming development	8	Capable of independently complete specific UAV programming development tasks	Preparation of programming and development knowledge for UAVs Modeling basic data collection Developing an AI model for image recognition 3D model data acquisition and 3D model establishment Autonomous flight route planning for UAVs Autonomous image collection Specific data processing Develop flight control through programming
Note	64 class hours in total			

7 Teaching implementation

7.1 Teaching organization

This course applies action oriented teaching philosophy in real or simulated work situations, focusing on the principle of combining theory with practice. Through a systematic course arrangement, from basic theoretical explanations to simulated flight training, and then to on-site operations and emergency response exercises, students gradually improve their UAV control skills, safety awareness, and problem-solving abilities. The course adopts a small class teaching mode to ensure that each student can receive sufficient guidance and practice opportunities, while incorporating interactive elements such as case analysis and group discussions to enhance the fun and effectiveness of learning.

7.2 Teaching methods

7.2.1 Method Overview

This course adopts an action oriented teaching method, with tasks as the guide. Representative work tasks derived from practical engineering will be transformed into learning tasks, and relevant knowledge points will be embedded into various learning tasks. Through various learning tasks, relevant knowledge and skills will be taught. Whatever tasks require, they will be taught and practiced, highlighting the cultivation of practical comprehensive vocational abilities.

This course aims to comprehensively cultivate students' UAV control skills, safety flight awareness, and emergency response abilities, laying a solid foundation for their future applications in multiple fields such as aerial photography, agriculture, and rescue. The teaching of this course focuses on the combination of theory and practice. Through various methods such as theoretical lectures and case analysis, simulation training and practical exercises, task-based learning and team cooperation, extracurricular expansion and self-learning, students' UAV control skills and comprehensive quality are comprehensively improved.

7.2.2 Theoretical lectures and case analysis

In the classroom, teachers adopt a systematic teaching method, using PPT presentations, vivid video materials to explain, and combining classic cases and accident cases of UAV operation at home and abroad for in-depth analysis, guiding students to draw lessons from them and enhance their awareness of safe flight and risk prevention and control abilities. In this section, students will learn core knowledge such as the basic structure of UAVs, flight principles, aviation regulations, and the impact of weather conditions on flight, helping them establish a solid theoretical foundation.

7.2.3 Simulation training and practical exercises

Utilizing advanced UAV simulators to simulate real flight environments, students can quickly familiarize themselves with UAV control procedures and improve flight stability. Subsequently, practical exercises will be conducted in a venue with safe conditions, with teachers providing on-site guidance to ensure that students complete various flight tasks safely and in a standardized manner. In this section, students will learn key operations such as UAV takeoff, landing, hovering, and route planning to enhance their practical control skills.

7.2.4 Task based learning and teamwork

Based on the course content and practical application scenarios, set a series of specific tasks, such as UAV aerial photography operations, agricultural plant protection spraying, etc. The students are divided into several groups, each responsible for a task. During the task execution process, students need to fully utilize their teamwork spirit, collaborate with each other, and jointly solve the problems encountered. In this section, students will participate in the entire process from task planning, scheme design, flight execution to data processing and analysis. Through task-based learning and teamwork, students will comprehensively enhance their problem-solving skills, innovative thinking, and teamwork abilities.

7.2.5 Extracurricular expansion and self directed learning

Organize students to visit UAV related companies, participate in UAV competitions or exhibitions, and experience the latest developments and industry application prospects of UAV technology firsthand. At the same time, by providing rich online learning resources, recommending relevant books and websites, students are encouraged to use their spare time for self-directed learning. By combining extracurricular expansion with self-directed learning, students can gain a deeper understanding of the latest developments in UAV technology and enhance their professional competence and competitiveness.

7.3 Teaching resources

7.3.1 Venue and facilities

The teaching of UAV operation courses requires a specially designed training room. This training room is equipped with multiple areas, including theoretical teaching area, simulated flight training area, practical operation area, equipment maintenance area, safety observation area, information retrieval area, and achievement display area. Each area has its specific teaching functions and safety requirements. The training room needs to have sufficient lighting and ventilation conditions to create a comfortable and efficient learning environment. At the same time, in order to ensure the safety of students, the training room is also equipped with necessary safety protection facilities, such as collision nets and emergency stop buttons.

7.3.2 Equipment and tools

Equipment and tools are crucial teaching resources in UAV operation courses. In order to ensure that every student has the opportunity to personally operate the UAV, the equipment needs to be equipped with a sufficient number of UAV systems, including key components such as the body, remote control, and battery. In addition, a complete set of maintenance tools, including screwdrivers, wrenches, battery testers, etc., should be provided for each student or group of students so that they can carry out daily maintenance and repair work. In order to improve students' flying skills, it is also necessary to equip them with a simulated flight training system, allowing them to conduct flight training in a virtual environment to reduce risks during actual flights.

7.3.3 Teaching materials

In order to help students better understand and master UAV operation technology, it is necessary to prepare a variety of teaching materials. These materials include but are not limited to paper versions of operation manuals, maintenance guides, flight safety regulations, etc. They can provide students with detailed technical guidance and safety knowledge. In addition, modern technological means need to be utilized to prepare multimedia materials such as presentations, teaching videos, and animated demonstrations, in order to demonstrate UAV operation skills and maintenance knowledge in an intuitive and vivid way. These teaching materials should help stimulate students' interest in learning and improve their learning outcomes.

7.3.4 Technical support and faculty

In the teaching of UAV operation courses, technical support and teaching staff are equally important. We need to build a teaching staff composed of experienced UAV experts and teachers who not only possess solid professional knowledge, but also have rich teaching experience. During the teaching process, they are able to provide comprehensive guidance and assistance to students, answering any questions they may encounter in learning and practice. At the same time, close cooperation should be established with UAV manufacturers, service providers, etc. to provide timely technical support and troubleshooting services for students. This powerful technical support and teaching staff are important guarantees for teaching quality and student learning outcomes.

8 Teaching evaluation

8.1 Evaluation objectives

The teaching evaluation of the UAV operation course aims to comprehensively test the students' mastery of UAV operation theory, skills, and safety regulations. Through diverse evaluation methods, it assesses the students' adaptability and ability level in actual work positions. Based on the assessment results, students are divided into three levels: A, B, and C, in order to provide scientific basis for subsequent career development and job allocation.

8.2 Evaluation method

8.2.1 Evaluation content

The teaching evaluation of UAV operation courses is comprehensively and objectively assessed through a combination of process assessment, practical results, simulated flight results, course design/project assignments, and exam scores. These evaluation methods not only help students to timely understand their learning progress and existing problems, but also provide important basis for teachers to adjust teaching methods and course content, thereby continuously improving the teaching quality and learning effectiveness of the course.

It is recommended to use a combination of process evaluation and summative evaluation for teaching assessment, with process evaluation accounting for 40% to 60% of the total score and summative evaluation accounting for 60% to 40% of the total score. After the course is completed, students' comprehensive vocational abilities will be assessed.

8.2.2 Process assessment and professional competence evaluation

Process assessment is the fundamental evaluation stage of UAV operation courses, which adopts a scoring or grading system. By establishing clear scoring criteria, it mainly tests the students' learning attitude, participation, and daily homework completion in the classroom. The evaluation content includes classroom attendance rate, enthusiasm for questioning and answering questions, contribution in group discussions, and the quality and timeliness of homework submission.

Adopting the internationally popular COMET (Competency Oriented Model of Educational Targets) assessment method, the comprehensive professional abilities of athletes are evaluated through written tests. COMET

International Vocational Ability Assessment Technology starts from 8 key competency indicators, including intuitiveness, functionality, value orientation, economy, work process orientation, social acceptance, environmental friendliness, and creativity. Through 40 specific observation points, it comprehensively and meticulously assesses students. Through this evaluation method, students' comprehensive professional abilities in the field of UAV operation can be more accurately understood, and corresponding professional ability levels can be evaluated based on this, providing important references for students' future career planning and development.

8.2.3 Final exam and skill passport

The practical results directly reflect the students' skill level and safety awareness in actual operation, comprehensively testing their understanding and mastery of course knowledge, skills, and methods. The evaluation of exam results adopts a percentage or grade system, and detailed scoring standards are formulated based on the exam outline and requirements to ensure fairness and consistency in the evaluation. The exam covers multiple aspects such as the basic principles, operating procedures, maintenance, safety regulations, and practical applications of UAVs.

As an important supplement to practical performance, simulated flight scores are used to evaluate students' flying skills and decision-making abilities in virtual environments through a simulated flight training system. The evaluation is conducted through a combination of system scoring and manual review. The evaluation content includes the planning of flight routes, control of flight speed, avoidance of obstacles, and response to emergencies.

Course design or project assignments are the application evaluation stage of UAV operation courses, requiring students to combine their learned knowledge to complete a specific UAV application project or research topic. The evaluation of course design or project assignments adopts a jury or review system, inviting industry experts or teacher teams for review to ensure the authority and professionalism of the evaluation. The evaluation content covers the selection of topics, the application of research methods, the innovation of solutions, the standardization of implementation processes, and the display and evaluation of final results.

At the end of the course, according to the assessment work plan, relevant experts will be organized to conduct a final assessment of the students. The assessment content of the Skill Passport exam closely revolves around the core skills of UAV operation, including but not limited to flight control, task execution, emergency response, and maintenance. Based on the performance of the students in the course learning process, such as process assessment and practical results, the skill level of the students will be comprehensively recognized, and corresponding international skill passports will be issued. The specific assessment criteria refer to the "UAV Operation Competition Skills Standards" to ensure the authority and professionalism of the evaluation.

Bibliography

[1] GZB 4－99－00-00 *Chinese National Vocational Skills Standards - Drone Pilots*

[2] GZB 6-23－03－15 *Chinese National Vocational Skills Standards - Unmanned Aerial Vehicle Installation and Maintenance Workers*

[3] AC－61－FS－2018－R2 *Civil Aviation Administration of China - Management Regulations for Civil Drone Pilots*

[4] AC－91－FS－2019－31R1 *Civil Aviation Administration of China - Operating Regulations for Light and Small Drones*

[5] ICAO Doc 10019 *Manual on Remotely Piloted Aircraft Systems(RPAS)*

[6] T/AOPA0008－2019 *China Aircraft Owners and Pilots Association - Civil UAV Pilot Qualification Certification Rules*