TN Department of Education | College, Career and Technical Education

May 2024

Unmanned Aircraft Systems in Agriculture

Primary Career Cluster:	Agriculture, Food, & Natural Resources
Consultant:	CTE.Standards@tn.gov
Course Code(s):	C18H40
Prerequisite(s):	*Any Level 2 course in an aligned AFNR program of study*
Credit:	1
Grade Level:	12
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture, Food, & Natural Resources courses.
POS Concentrator	This course satisfies one out of two required courses that must be taken from a single program of study to meet the Perkins V concentrator definition requirements.
Programs of Study and Sequence:	This is the fourth or optional fifth course *within the Agriculture, Food, and Natural Resources* program of studies.
Aligned Student Organization(s):	FFA: http://www.tnffa.org
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, teachers who hold an active WBL certificate may offer placement for credit when the requirements of the state board's WBL Framework and the Department's WBL Policy Guide are met. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	048, 150, 448, and 950
Required Teacher Certifications/Training:	FAA Remote Pilot Certification (Part 107)
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html Best for All Central https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st century skills necessary to be successful in career and in life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards which feed into intentionally designed programs of study.

Students engage in industry relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry standard content and technology, solve industry-based problems, meaningfully interact with industry professionals and use/produce industry specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for your students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. This is not an exhaustive list.

- Participate in CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry specific skills that involve teamwork and project management.
- Participate in FFA career and leadership events (CDE/LDE) that align with this course including Agriscience Fair, Agricultural Communication, Agricultural Issues, and Employment Skills

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1.1-2.3** | Invite a drone pilot from the local agribusiness company to discuss career opportunities and safety.
- **Standards 3.1-4.6** | Virtually work with an FAA representative to classify local airspace and outline operating requirements.
- **Standards 5.1-5.8** | Visit a drone pilot from a local agricultural company or agency while delivering payloads directly to a given location.

Course Description

The *Unmanned Aircraft Systems (UAS) in Agriculture* course is an advanced course in *Agriculture, Food, and Natural Resources* career cluster intended to meet the needs of specific applications of advanced UAS precision technologies specific to the agriculture, food, and natural resources industry. Students will receive rigorous instruction in preparation to take the the Federal Aviation Administration (FAA) remote Pilot Certification (Part 107) (less than 55 pounds) exam for the commercial drone pilots for small Unmanned Aircraft Systems (sUAS) and develop specific knowledge and skills associated with specific sUAS technologies, platforms and precision attachments to monitor, map, and provide data to make agricultural management and production recommendations.

Course Standards

1. Safety

1.1 Operational Safety: Accurately read and interpret **safety rules related to operating and using small Unmanned Aircraft Systems (sUAS) and attachments**. Demonstrate safe operation procedures with appropriate attitudes and behaviors associated with operating sUAS. Complete safety test with 100 percent accuracy.

1.2 Emergency Procedures. Employ appropriate **emergency procedures**. Explain reporting requirements for in-flight emergencies and appropriate action during loss of aircraft control link and fly-aways.

1.3 Flight Operations Over People. Explain **safe flight operations over people**. Plan a mission that requires safe flight operations over people.

2. UAS Industry and Occupational Awareness

2.1 Evolution of UAS: Research and summarize the **origins, development, and evolution of commercial small Unmanned Aircraft Systems (sUAS) operations**. Explain the important systems, people, and technologies in the development of the sUAS industry in addition to the following:

a. limitations and constraints placed on the development of commercial sUAS;
b. evolution of sUAS regulatory framework and process, technologies that led to modern day sUAS;
c. important events leading to the development of sUAS;
d. classification schemes of sUAS; and
e. intelligence modes of control for sUAS.

2.2 Careers: Identify and describe career opportunities using small Unmanned Aircraft Systems (sUAS) technology field and positions related to the agriculture industry. Analyze current **sUAS jobs, job locations, salaries, and upcoming career shifts**, related to sUAS technology.

2.3 Precision Technologies: Compare and contrast the **types and functions of precision and advanced technologies** (e.g., GIS, GPS, and sensors) available to improve efficiency and efficacy in the agricultural industry.

3. Airspace classification and Operating Requirements

3.1 Performance: Exhibit a thorough understanding of small Unmanned Aircraft Systems (sUAS) **technologies, platforms, and systems to determine capabilities and limitations,** such as payload elements, stabilization and navigation sensors, environmental operation conditions, life and operational cycles, and operational considerations.

3.2 Operation Requirements: Examine the **operating requirements of small Unmanned Aircraft Systems (sUAS)** including:

a. differentiation of the different autonomy levels of sUAS;
b. identify and explain the purpose of a ground control station;
c. operation regulations over human beings;
d. requirements of a visual observer;
e. basic rules of safe operation;
f. aircraft safety of flight principles;
g. requirements for the sUAS to be in a condition for safe operation; and
h. a hazardous operations plan.

3.3 FAA Regulations: Summarize and demonstrate the **Federal Aviation Authority (FAA) regulations associated with the operation of small Unmanned Aircraft Systems (sUAS)** including registration requirements, categories of vehicles, system operators, ramifications of false reporting, accident reporting, and prohibition of operating multiple sUAS.

3.4 Airspace Classification: Classify **airspace, including general, special, and other airspaces**. Describe the operating requirements in airspaces including restrictions due to Notice to Airmen (NOTAM). Given a specific region on aeronautical maps and using researched sources of information, identify authorizations required, maximum altitudes, unauthorized areas, and other points of risk or concerns for the sUAS operator.

3.5 Principles of Flight: Explain the **fundamentals and principles of flight** as they relate to small Unmanned Aircraft Systems (sUAS). Include aeronautical principles, aerodynamics, Lift, drag, thrust, weight, acceleration, objects in motion through the air, and the forces that produce change to such motions.

3.6 Charts: Read and interpret **sectional charts, aeronautical charts, and chart supplements**. Identify classifications of airspace, latitude, longitude, obstacles, and navigation routes, the meaning of symbols, key terms, and other specific words related to small Unmanned Aircraft Systems (sUAS). Examples include ICAO Location Indicator, Warning Areas, Outer Boundaries, and Temporary Flight Restrictions (TFR) Sites.

3.7 Radio Communications: Demonstrate **effective communication skills while using proper radio communication procedures** including Zulu time and the phonetic alphabet. Explain the various transmitters and demonstrate knowledge of aircraft communication equipment.

4. Performance, Weather, and Restrictions

4.1 Human Factors: Compare the differences in **human factors related to the operational control, ground control, and personnel required to operate small Unmanned Aircraft Systems (sUAS).** Summarize how the different types of human actions and automatic sensory factors impact the different types of human operator errors.

4.2 Preflight Planning: Articulate the **components of preflight planning to access risk.** Be prepared to outline the risk assessment, a maintenance schedule, and conduct a preflight inspection.

4.3 Devices: Investigate and compare the **various small Unmanned Aircraft Systems (sUAS), cameras, and sensoring systems** to make recommendations for specific agricultural applications.

4.4 Weather: Using Aviation weather reports (METAR), Terminal Aerodrome Forecasts (TAF), and other weather reports from various sources, analyze weather reports to interpret **weather conditions for operating** a small Unmanned Aircraft Systems (sUAS).

4.5 Pilot in Command: Describe the **responsibility and authority of the pilot in command (PIC)** for a small Unmanned Aircraft System (sUAS) mission. Plan and implement a sUAS mission. The mission will include creating an autonomous flight plan that is safe, fully complies with FAA regulations within the National Airspace, and completes the planned objective. Demonstrate the PIC responsibilities for each step of a mission (e.g., mission planning, pre-flight, normal in-flight, abnormal in-flight, emergency in-flight, and post-flight debrief).

4.6 Night Operations: Explain **night operations** with a small Unmanned Aircraft System (sUAS). Plan the various steps of a night mission with a sUAS.

5. Payload, Stressors, and Data Collection

5.1 Loading: Explain the **processes of loading and payload** as it applies to small Unmanned Aircraft Systems (sUAS), including the historical payload uses and the prohibitions for carrying hazardous materials. Determine the impact of a load on performance by calculating the in-flight weight of the payload using load factor charts to maintain specific altitudes.

5.2 Data Collection – Plant Nutrient: Create a plan for using small Unmanned Aircraft Systems (sUAS) remote sensing technology to **identify nutrient deficiencies to monitor plant growth.** Describe which remote sensing technology should be used to **examine the processes of plant growth** to conduct chlorophyll counts.

5.3 Data Collection – Soils: Describe how small Unmanned Aircraft Systems (sUAS) are used to **analyze soil properties utilizing remote sensing technology**. Develop a plan to use sUAS technology in best management practices for soil moisture and irrigation. Assess irrigation application effectiveness using sUAS technology.

5.4 Data Collection – Animal Production: Determine uses for small Unmanned Aerial Systems (sUAS) to **monitor companion animals, livestock and wildlife operations**. Differentiate the signs and symptoms of common disease and other issues such as but not limited to identifying herd health issues, nutritional issues, predator issues, calculating calving percentages by using sUAS remote sensing.

5.5 Data Collection – Crop Production: Determine the small Unmanned Aerial Systems (sUAS) remote sensing applications needed to **identify common forages pest and disease that impact plant growth and nutritional levels**. Analyze **data to identify and provide management recommendations for forage, hay crops, and food plots** serving as a source of nutrition for animals.

5.6 Data Collection – Pest Management: Identify **pest and disease damage in plants** using small Unmanned Aerial Systems (sUAS) remote sensing technology. Recommend appropriate solutions for pest and disease control by developing an integrated pest management (IPM) plan using information from sUAS technology.

5.7 Data Collection – Crop Management: Determine the proper small Unmanned Aerial Systems (sUAS) **attachment to provide data** on agricultural crops such as but not limited to vegetable, row, nursery, native vegetation, fruit, etc. Develop a **data management report** for a diversified farming operation with at least three different crops, including:

a. identification of common pest and diseases,
b. use of sUAS for early detection of diseases,
c. calculate yield estimates using sUAS data, and
d. evaluate and monitor crops to predict growth and harvest times.

5.8 Data Collection – Forest Management: Identify small Unmanned Aerial Systems (sUAS) **attachments and techniques to provide forest management data** including the identification of economically important tree species, forest pest, insects, and diseases. Create a forest management plan based on images and data from a sUAS.

Standards Alignment Notes

References to other standards include:

- SAE for All: Evolving the Essentials: All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program to practice and demonstrate the knowledge and skills learned in their agriculture courses.
- AFNR: National Agriculture, Food, & Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards NRS. 02.03, 03.02,04, ESS.01, 02, 05, and PST 05at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.
- Work-Based Learning Framework opportunities (such as internships, cooperative education, service learning, and job shadowing) or industry-driven project-based learning. These experiences must comply with the Work-Based Learning Framework guidelines established

in SBE High School Policy 2.103. As such, this course must be taught by a teacher with an active WBL Certificate issued by the Tennessee Department of Education and follow policies outlined in the Work-Based Learning Policy Guide available online at https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.