Unmanned Aircraft Systems in Agriculture

Primary Career Cluster:	Agriculture, Food, & Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	C18HXX
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.
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 Vacant, Executive FFA Secretary, Stena Meadows, East Tennessee FFA Consultant, (423) 414-8669, Stena.Meadows@tn.gov Brad Parton, Middle Tennessee FFA Consultant, (615) 253-5207, Brad.Parton@tn.gov Emily Grant, West Tennessee FFA Consultant, (731) 431-1183, Emily.Grant@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. Also, teachers are encouraged to use embedded WBL activities. For information, visit https://www.tn.gov/content/tn/education/career-and-technical-education/work-based-learning.html.
Available Student Industry Certifications:	• FAA Remote Pilot Certification (Part 107) • AEST Unmanned Aircraft Systems in Agriculture Certification (Pending approval & modifications) - or Tennessee Specific Industry Certification (TSIC) for Unmanned Aircraft Technologies for Agriculture (UATA) (pending approval & development)
Teacher Endorsement(s):	048, 150, and 448
Required Teacher Certifications/Training:	FAA Remote Pilot Certification (Part 107)
Teacher Resources:	https://www.tn.gov/content/tn/education/career-and-technical-education/work-based-learning.html

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.

Program of Study Application

This course is an optional fourth course in either the *Agricultural Engineering & Applied Technology, Environmental & Natural Resources Management, Horticulture Science, and the Veterinary & Animal Science program of studies within the Agriculture, Food, and Natural Resources* career cluster. This course includes the drone (Part 107) commercial pilot license and students must be at least 16 years old to take the Part 107 exam. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food, & Natural Resources website at https://tn.gov/education/article/cte-cluster-agriculture-food-natural-resources.

Course Standards

Safety

1. 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.

UAS Industry and Occupational Awareness

2. Research and summarize the origins, development, and evolution of commercial small Unmanned Aircraft Systems (sUAS) operations citing primary sources, state and federal laws and regulations, and secondary sources, industry publications. Construct a group presentation explaining 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.

3. Gather relevant information from multiple sources in both print and digital formats related to career opportunities using small Unmanned Aircraft Systems (sUAS) technology, including but not limited to current careers, upcoming career shifts related to sUAS technology, and how sUAS positions are related to the agriculture industry. Research notable historical figures, time periods, technological advancements and/or practices to

develop a visual, oral, and/or written presentation that cites specific textual evidence to support analysis.

4. Compare and contrast the types and functions of precision and advanced technologies (such as GIS, GPS, and unmanned aircraft systems) available to the agriculture industry. Citing technical data and academic research, compare in a written or oral format the legal, ethical, and economic impact of using emerging technologies to improve efficiency and efficacy in the agricultural industry.

Airspace classification and Operating Requirements

5. Analyze small Unmanned Aircraft Systems (sUAS) technologies, platforms, and systems to determine capabilities and limitations such as payload elements, stabilization & navigation sensors, environmental operation conditions, life & operational cycles, and operational considerations. Using the information gathered, create a sUAS operational presentation.

6. Synthesize information from credible sources, use a graphic organizer to create an outline of the operating requirements of a 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. hazardous operations plan.

7. Summarize and demonstrate the 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 small UAS.

8. 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.

9. Analyze the fundamentals and principles of flight to produce a written or oral presentation relating to small Unmanned Aircraft Systems (sUAS). The presentation should include but not limited to aeronautical principles, aerodynamics, objects in motion through the air, and the forces that produce change to such motions. Include responsibility and authority of Pilot in Charge (PIC.)

10. Read and interpret sectional charts, aeronautical charts, and chart supplements. Identify classifications of airspace, latitude, longitude, obstacles, and navigation routes. Include the

meaning of symbols, key terms, and other specific words related to small Unmanned Aircraft Systems (sUAS) as they are used in technical context.

11. Demonstrate effective communication skills while using proper radio communications procedures including Zulu time and the phonetic alphabet. Explain the various transmitters. Demonstrate knowledge of aircraft communication equipment.

Performance, Weather, and Restrictions

12. Compare the differences of 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.

13. Articulate the components of preflight planning to access risk. Be prepared to outline the risk assessment, a maintenance schedule, and conduct a preflight inspection.

14. Investigate and compare the various small Unmanned Aircraft Systems, cameras, and sensoring systems to make recommendations for specific agricultural applications.

15. 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).

16. Using small Unmanned Aircraft Systems (sUAS), 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. Serve as remote Pilot In Charge (PIC) for the mission. Demonstrate situational awareness and perform risk mitigation during the flights. Demonstrate standards of professionalism during flights. Demonstrate an understanding of mission planning, preparation, execution, and post-flight debrief.

Payload, Stressors, and Data Collection

17. Explain the processes of loading and payload as it applies to small Unmanned Aircraft Systems (sUAS) including the historical payload uses and prohibitions for carrying hazardous materials, citing technical manuals. 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.

18. Create a plan for small Unmanned Aircraft Systems (sUAS) to monitor plant growth and describe which sUAS remote sensing technology should be used to examine the processes of plant growth to conduct chlorophyll counts. Using this sUAS remote sensing technology identify nutrient deficiencies.

19. Describe how small Unmanned Aircraft Systems (sUAS) are used to analyze soil properties using remote sensing technology. Develop a plan to use sUAS technology in best

management practices for soil moisture/irrigation. Assess irrigation application effectiveness using sUAS technology.

20. Determine uses for small Unmanned Aerial Systems (sUAS) to monitor companion animals, livestock & wildlife operations. Differentiate the signs and symptoms of common disease and other issues such as but not limited to identifying heard health issues, nutritional issues, predator issues, calculating calving percentages of using sUAS remote sensing.

21. 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, food plots serving as a source of nutrition for animals.

22. Differentiate between nutrient deficiencies and pest/disease damage in plants using small Unmanned Aerial Systems (sUAS) remote sensing technology. Identify pests and diseases and the damage they cause. Recommend appropriate solutions for pest and disease control by developing an integrated pest management (IPM) plan using information from sUAS technology.

23. Determine the proper small Unmanned Aerial Systems (sUAS) applications 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 to contain at least:
    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.

24. Selecting small Unmanned Aerial Systems (sUAS) applications and techniques to provide forest management data including the identification of economically important tree species, forest pest, insects, and diseases. Create a written recommended forest management plan based on the data from sUAS images and data.

Standards Alignment Notes

References to other standards include:

- SAE: Supervised Agricultural Experience: All Agriculture students are encouraged to participate in a Supervised Agricultural Experience 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/career-and-technical-education/work-based-learning.html.