Aviation of UAS and Drone Technology

Level: 3
Career Cluster: Advanced Manufacturing
Program: Engineering
Pathway(s): Engineering Applications UAS

Course Catalog Description

Introduces students to the fundamentals of unmanned aircraft systems (UAS) and drone technology, including flight systems, navigation, regulations, safety, and real-world applications. Students develop technical knowledge and problem-solving skills through mission planning, data analysis, and a capstone drone mission project.

Summary

This course introduces students to the aviation, engineering, and operational principles that drive unmanned aircraft systems (UAS) and drone technology. Students explore career pathways, professionalism, postsecondary opportunities, and industry expectations while building knowledge of flight systems, drone components, controls, stability, navigation, and communication systems. Through the study of FAA regulations, airspace, weather, safety procedures, and ethical decision-making, students learn to evaluate risks and make informed operational choices. The course also emphasizes mission planning, data collection, and real-world drone applications across industries such as public safety, agriculture, mapping, inspection, media, and infrastructure. In addition to technical content, students strengthen leadership, collaboration, and employability skills through project-based learning, communication tasks, and work-based learning experiences that connect classroom instruction to industry practice.

Notes

This revised course updates the previous version by shifting from a broad advanced aviation/UAS survey with significant emphasis on private pilot written exam preparation to a more clearly defined drone-focused pathway centered on unmanned aircraft systems, engineering applications, FAA regulations, airspace, weather, navigation, communication systems, mission planning, data collection, and real-world industry use. While the earlier course included a wider mix of traditional aviation concepts and exam-oriented content, this updated version places stronger emphasis on the technical, operational, and problem-solving skills students need for modern drone-related pathways and industry applications. The new course is also more intentionally organized around clearly sequenced student learning outcomes with measurable objectives, making the progression of knowledge and skills easier to follow and more aligned to Colorado CTE expectations. In addition, it expands the course beyond technical content by adding dedicated leadership and work-based learning components, reinforcing professionalism, collaboration, ethical decision-making, and career readiness. The revised structure culminates in a capstone drone mission project that provides students with an opportunity to apply technical knowledge in an authentic, project-based context and better reflects current workforce and postsecondary expectations in UAS and drone technology.

Student Learning Outcomes

1. Career Exploration and Postsecondary Opportunities

Objective: *Students will analyze career pathways in engineering and drones by exploring industry roles, workplace expectations, required education, certifications, professional organizations, and postsecondary opportunities available in Colorado in order to make informed academic and career decisions.*

1) Identify employment opportunities in various fields with a focus in the area of engineering and drones
    a. Recognize the work typically performed, tools and technology used, and nature of work environments
    b. Identify potential certifications within the careers
    c. Find membership organizations associated with the careers
    d. Understand the necessary education associated within the careers
2) Define professionalism within the context of engineering and drones
    a. Criticism and evaluation
    b. Presentation
    c. Assessment
3) Recognize laws, regulations, and ethics significant to the fields of engineering and drones
4) Identify postsecondary opportunities offered in the state of Colorado
    a. Technical college, community college, 4-year institutions
    b. Certificates, associates, bachelor, and advanced degree opportunities

2. Foundations of Aviation and Drone Flight Systems

Objective: *Students will explain the basic principles of aviation and how they apply to drone flight systems.*

5) Define flight principles including lift, drag, thrust, and weight
6) Explain how drones achieve and maintain flight
7) Compare fixed-wing and rotary-wing aircraft with multirotor drones
8) Identify key components of drone systems including motors, propellers, frames, and controllers
9) Analyze how engineering design influences drone performance
10) Interpret how design choices affect stability, speed, and endurance

3. Drone Components, Systems, and Engineering Design

Objective: *Students will analyze drone subsystems and evaluate how components work together in an integrated system.*

11) Identify major components including flight controllers, ESCs, GPS modules, sensors, and batteries
12) Explain how electrical, mechanical, and software systems interact in drones
13) Analyze system inputs and outputs within a drone platform
14) Evaluate the impact of component selection on flight capability

15) Compare different drone configurations and use cases
16) Design a conceptual drone system based on a given mission

4. Flight Controls, Stability, and Navigation Basics

Objective: *Students will apply flight control principles to understand drone maneuverability and navigation.*

17) Explain how pitch, roll, yaw, and throttle affect drone movement
18) Demonstrate basic control inputs through simulation or modeling
19) Analyze how stabilization systems maintain smooth flight
20) Interpret telemetry data from drone systems
21) Compare manual flight control with automated navigation systems
22) Evaluate how environmental conditions affect control and stability

5. Airspace, Regulations, and Safe Drone Operations

Objective: *Students will interpret aviation regulations and apply legal requirements to drone operations.*

23) Identify FAA regulations relevant to drone operations
24) Explain classifications of airspace and operating restrictions
25) Analyze how regulations impact flight planning and mission execution
26) Evaluate compliance requirements for recreational and commercial drone use
27) Apply safety procedures to preflight and inflight operations
28) Justify operational decisions using regulatory guidelines

6. Weather and Environmental Impacts on Drone Flight

Objective: *Students will analyze weather conditions and evaluate their impact on drone performance and safety.*

29) Identify key weather factors including wind, temperature, visibility, and precipitation
30) Explain how environmental factors influence drone performance
31) Interpret weather data relevant to flight planning
32) Analyze how weather affects battery life, control, and safety
33) Predict outcomes of flight scenarios based on weather conditions
34) Recommend safe operational decisions based on environmental inputs

7. Navigation Systems, GPS, and Autonomous Flight

Objective: *Students will evaluate navigation technologies and apply them to drone mission planning.*

35) Explain how GPS and satellite navigation systems work
36) Identify components of autonomous flight systems
37) Compare manual navigation with GPS-based and waypoint navigation
38) Analyze the role of sensors in navigation and obstacle avoidance
39) Design a waypoint-based drone mission plan
40) Evaluate the accuracy and limitations of navigation systems

8. Mission Planning, Data Collection, and Applications

Objective: *Students will apply aviation and engineering concepts to design drone missions for real-world applications.*

41) Define mission objectives and constraints
42) Plan drone operations for tasks such as mapping, inspection, or delivery
43) Analyze data collected from drone sensors and cameras
44) Evaluate mission effectiveness based on performance criteria
45) Compare drone applications across industries
46) Propose improvements to mission design and execution

9. Safety, Risk Management, and Ethical Drone Use

Objective: *Students will evaluate risks and apply ethical decision-making in drone operations.*

47) Identify operational risks including technical failures and environmental hazards
48) Explain ethical concerns related to privacy, surveillance, and data use
49) Analyze safety incidents and determine contributing factors
50) Evaluate risk mitigation strategies
51) Apply safety protocols to reduce hazards
52) Defend ethical decisions using real-world scenarios

10. Communication Systems and Drone Operations

Objective: *Students will explain communication systems and analyze their role in safe drone operation.*

53) Describe how communication links connect controllers and drones
54) Explain concepts such as signal strength, interference, and latency
55) Analyze risks associated with signal loss
56) Evaluate communication system reliability
57) Apply troubleshooting strategies to communication issues
58) Recommend safe procedures for maintaining signal integrity

11. Drone Mission Design Project

Objective: *Students will design, develop, and present a comprehensive drone mission that integrates aviation and engineering concepts.*

59) Define a real-world drone mission problem
60) Develop a complete operational plan including route, weather, and airspace considerations
61) Apply avionics, navigation, and safety practices to the project
62) Evaluate mission performance through testing or simulation
63) Present findings using technical language and supporting evidence
64) Justify design choices and recommend improvements

12. Leadership

Objective: *Students will demonstrate leadership skills through communication, teamwork, ethical decision-making, and participation in career and technical student organization activities related to aviation, engineering, and drone technology.*

65) Identify characteristics of effective leaders in aviation, engineering, and drone-related fields
66) Demonstrate leadership skills through collaboration, communication, and responsible decision-making
67) Apply teamwork and conflict-resolution strategies in classroom, lab, and project environments
68) Participate in leadership development activities through CTSO or other career-connected experiences
69) Evaluate the role of ethics, responsibility, and professionalism in leadership situations
70) Develop personal leadership goals that support academic, career, and workplace success

13. Work-Based Learning

Objective: *Students will connect classroom learning to career pathways by engaging in work-based learning experiences, reflecting on workplace expectations, and applying technical and employability skills in authentic industry settings.*

71) Identify workplace expectations, responsibilities, and professional behaviors in aviation and drone-related settings
72) Explore work-based learning opportunities such as job shadows, guest speakers, industry projects, internships, or workplace experiences
73) Apply technical knowledge and employability skills in authentic workplace tasks
74) Communicate effectively with peers, instructors, and industry partners in work-based learning environments
75) Reflect on work-based learning experiences to evaluate strengths, areas for growth, and career interests
76) Document skills, experiences, and accomplishments that support postsecondary and career readiness

14. Career and Technical Student Organizations

Objective: *Using the CTSO Resource Document, chapter activities will provide some of the best opportunities CTSO members will have to learn by doing. A successful program of work creates a positive learning atmosphere in the classroom. CTSO members learn how to accept responsibility, work as a team, manage a budget, and handle success and failure. Per the CTE Admin Handbook, CTSOs are embedded into curriculum.*

Professional Development

Prepare each member for entry into the workforce and provide a foundation for success in a career. Becoming a professional does not stop with acquiring a skill, but involves an increased awareness of the meaning of good citizenship and the importance of labor and management in the world of work.

Community Service

Promote and improve goodwill and understanding among all segments of the community through services donated by CTSO chapters, and to instill in its members a lifetime commitment to community service.

Business and Industry Connections

Increase awareness of quality job practices and attitudes, and increase the opportunities for employer engagement and eventual employment.

Financial Leadership

Plan and participate in activities to allow all members to carry out the chapter's projects. Educate members on their own personal finance for current and future success.

Public Relations

Make the general public aware of the good work that students in career and technical education are doing to better themselves and their community, state, nation, and world.

Social Activities

To increase cooperation in the school and community through activities that allow CTSO members to get to know each other in something other than a business or classroom setting.

Academic Standards Alignment

Colorado CTE courses are required to integrate academic and essential skills into course content. The following academic standards have been identified as aligned to this course and should be integrated throughout instruction.

CO CTE Academic Standards Resources (Rubrics, integration strategies, etc)
CDE Colorado Academic Standards Online (Online standards lookup tool)

Note: Mathematics and Science standards will be added in the future. Visit the Colorado Academic Standards page for the most current version.

Reading, Writing and Communicating Crosswalk

Course: Aviation of UAS and Drone Technology
Colorado Academic Standards – Reading, Writing, and Communicating

Standard	Prepared Graduate Competency	Description	Course Evidence / Alignment
Standard 1: Oral Expression and Listening	Prepared Graduate 1 – Collaboration	Collaborate effectively as group members or leaders who listen actively and respectfully; pose thoughtful questions, acknowledge the ideas of others; and contribute ideas to further the group's attainment of an objective.	Students work collaboratively on UAS flight operations, simulations, and problem-solving tasks; communicate safety roles and operational responsibilities; and listen to and incorporate peer/instructor feedback during planning and execution.
Standard 1: Oral Expression and Listening	Prepared Graduate 2 – Oral Presentations	Deliver effective oral presentations for varied audiences and varied purposes.	Students verbally explain flight plans, operating procedures, and corrective actions; communicate safety considerations and airspace decisions; and present operational reasoning during scenario-based UAS activities.
Standard 2: Reading for All Purposes	Prepared Graduate 4 – Informational Texts	Read a wide range of informational texts to build knowledge and to	Students read and interpret FAA regulations related to unmanned aircraft systems, use

		better understand the human experience.	airspace charts and operating manuals alongside safety documentation, and analyze technical information related to drone systems and applications.
Standard 2: Reading for All Purposes	Prepared Graduate 5 – Language in Context	Understand how language functions in different contexts, command a variety of word-learning strategies to assist comprehension, and make effective choices for meaning or style when writing and speaking.	The course requires students to use discipline-specific UAS/aviation terminology accurately, apply precise language for safety, regulation, and operation, and select language appropriate to technical, procedural, and evaluative contexts.
Standard 3: Writing and Composition	Prepared Graduate 6 – Craft arguments	Craft arguments using techniques specific to the genre.	Students justify flight decisions and operational limitations, defend compliance choices related to safety, airspace, and weather, and support claims with regulatory, technical, and observational evidence.
Standard 3: Writing and Composition	Prepared Graduate 7 – Informational Writing	Craft informational/explanatory texts using techniques specific to the genre.	Students write explanations of UAS systems and flight procedures, produce written descriptions of operational plans and outcomes, and create technical documentation aligned to aviation standards.
Standard 3: Writing and Composition	Prepared Graduate 9 – Writing Process	Demonstrate mastery of their own writing process with clear, coherent, and error-free polished products.	Students draft, revise, and finalize written flight plans, reports, and explanations, producing clear, accurate, professional documentation consistent with aviation expectations.

Standard 4: Research Inquiry and Design	Prepared Graduate 10 – Research and Ethics	Gather information from a variety of sources; analyze and evaluate its quality and relevance; and use it ethically to answer complex questions.	Students research FAA rules, airspace requirements, and drone applications; analyze weather, environmental, and operational data; and use information ethically to inform safe and effective UAS operations.

Free Resource Links

1. Career Exploration and Postsecondary Opportunities

- Bureau of Labor Statistics Drone and Aviation Careers (drone careers aviation jobs education pathways) https://www.bls.gov/ooh
- FAA Become a Drone Pilot (FAA certification Part 107 careers training pathways) https://www.faa.gov/uas
- CareerOneStop Engineering Careers (career pathways certifications workforce skills) https://www.careeronestop.org
- NASA STEM Careers (STEM aviation engineering workforce opportunities) https://www.nasa.gov/stem

2. Foundations of Aviation and Drone Flight Systems

- NASA Beginner Guide to Aeronautics (lift drag thrust weight flight basics) https://www.grc.nasa.gov
- FAA Pilot Handbook of Aeronautical Knowledge (flight principles aerodynamics aircraft systems) https://www.faa.gov
- MIT Aerodynamics Resource (flight principles airfoil forces engineering concepts) https://web.mit.edu
- How Drones Fly DJI (drone flight principles multirotor aerodynamics basics) https://www.dji.com

3. Drone Components, Systems, and Engineering Design

- DJI Drone Components Guide (drone parts motors controllers sensors overview) https://www.dji.com
- SparkFun Electronics Tutorials (electronics components sensors microcontrollers basics) https://learn.sparkfun.com
- Arduino Drone Projects (microcontrollers sensors engineering design applications) https://projecthub.arduino.cc
- NASA Engineering Design Process (engineering system design problem solving steps) https://www.nasa.gov/stem

4. Flight Controls, Stability, and Navigation Basics

- NASA Aircraft Control Systems (pitch roll yaw flight control systems) https://www.grc.nasa.gov
- FAA Flight Controls Overview (control surfaces stability aircraft control basics) https://www.faa.gov
- DJI Flight Control Systems (drone control flight stabilization sensors) https://enterprise.dji.com
- Khan Academy Physics Motion (forces motion control stability concepts) https://www.khanacademy.org

5. Airspace, Regulations, and Safe Drone Operations

- FAA UAS Regulations (drone laws Part 107 airspace compliance safety rules) https://www.faa.gov/uas
- B4UFLY App Airspace Tool (airspace awareness drone flight planning safety) https://www.b4ufly.aloft.ai
- SKYbrary Airspace Basics (airspace classes aviation regulations safety) https://www.skybrary.aero
- CISA Drone Safety Guidance (drone safety risk awareness operations guidelines) https://www.cisa.gov

6. Weather and Environmental Impacts on Drone Flight

- NOAA Weather Service Aviation (weather impacts wind visibility safety aviation) https://www.weather.gov
- Aviation Weather Center (weather reports METAR TAF flight planning) https://aviationweather.gov
- NASA Weather and Climate (weather systems atmosphere aircraft impacts) https://climate.nasa.gov
- UAV Forecast Tool (drone weather planning wind visibility battery impact) https://www.uavforecast.com

7. Navigation Systems, GPS, and Autonomous Flight

- GPS Government Resource (GPS navigation satellite positioning basics) https://www.gps.gov
- FAA Navigation Systems Guide (navigation aids GPS RNAV aviation basics) https://www.faa.gov
- DJI Waypoint Navigation (autonomous flight waypoint mission planning) https://www.dji.com
- ESRI GIS Basics (mapping geolocation data spatial analysis) https://www.esri.com

8. Mission Planning, Data Collection, and Applications

- DroneBlocks Mission Planning (drone missions waypoint coding planning tools) https://droneblocks.io
- ESRI Drone Mapping (drone mapping GIS data collection applications) https://www.esri.com
- NASA Earth Observation Missions (data collection remote sensing applications) https://earthobservatory.nasa.gov
- Pix4D Mapping Platform (drone mapping photogrammetry data analysis) https://www.pix4d.com

9. Safety, Risk Management, and Ethical Drone Use

- FAA Safety Risk Management Handbook (risk identification mitigation aviation safety) https://www.faa.gov
- Common Sense Digital Citizenship (ethics privacy safe technology use) https://www.commonsense.org/education

- CISA Cybersecurity for Drones (security risks drone systems safety awareness) https://www.cisa.gov
- SKYbrary Aviation Safety (safety risk management aviation operations) https://www.skybrary.aero

10. Communication Systems and Drone Operations

- FAA Communications Guide (aviation communication procedures terminology basics) https://www.faa.gov
- SKYbrary Communication Systems (aviation communication protocols ATC basics) https://www.skybrary.aero
- DJI Remote Controller Technology (signal transmission communication drone systems) https://www.dji.com
- Cisco Networking Basics (network communication wireless systems fundamentals) https://www.netacad.com

11. Drone Mission Design Project

- NASA Engineering Projects (engineering design problem solving project ideas) https://www.nasa.gov/stem
- DroneBlocks Project Library (drone mission design coding projects) https://droneblocks.io
- ESRI StoryMaps Projects (data storytelling mapping project development) https://storymaps.arcgis.com
- MIT Maker Resources (engineering design prototyping project development) https://makerspaces.mit.edu

12. Leadership

- NCC-CTSO Overview (CTSO leadership career readiness student leadership development) https://www.ctsos.org/
- Overcoming Obstacles Life Skills Curriculum (communication decision-making goal setting leadership skills) https://www.overcomingobstacles.org/
- Youth.gov Shared Resources (youth leadership civic engagement teamwork service learning) https://youth.gov/shared-resources
- PBS LearningMedia Leadership Resources (leadership communication teamwork classroom activities) https://www.pbslearningmedia.org/

13. Work-Based Learning

- CareerOneStop Internships (internships work experience career exploration student readiness) https://www.careeronestop.org/FindTraining/Types/internships.aspx
- GetMyFuture Get Work Experience (job shadowing volunteer work school activities employability) https://www.careeronestop.org/GetMyFuture/Employment/get-work-experience.aspx
- CareerOneStop Toolkit (career readiness job search resume skills training tools) https://www.careeronestop.org/Toolkit/toolkit.aspx

Technology Student Association – National Competitive Events

Drone Challenge (UAV)

Objective: *Students will design, build, document, test, fly, and present an open-source UAV drone that meets TSA Drone Challenge requirements for safety, flight performance, documentation, and mission completion.*

- Research the annual TSA Drone Challenge specifications, mission requirements, safety expectations, and applicable drone regulations.
- Design or modify an open-source UAV drone that meets TSA requirements for size, motors, propellers, guards, payload, camera, and mission function.
- Assemble and configure drone components, including motors, flight controller, electronic speed controllers, camera, antenna, and related systems.
- Document the UAV through a portfolio that includes photo logs, wiring schematics, programming explanation, engineered drawings, bill of materials, and work log.
- Test and troubleshoot the drone during setup, safety inspection, flight practice, and mission preparation.
- Complete the timed flight challenge according to TSA procedures.
- Participate in an interview explaining the drone design, components, programming, safety decisions, and mission performance.

Resources

- Technology Student Association – Drone Challenge (UAV) competition guidelines https://tsaweb.org/competitions-programs/tsa/themes-problems
- Federal Aviation Administration – Drone safety and regulations https://www.faa.gov/uas
- ArduPilot Documentation – Open-source autopilot software https://ardupilot.org/
- PX4 Autopilot User Guide https://docs.px4.io/

Technology Student Association – National Competitive Events

Geospatial Technology

Objective: *Students will collect, analyze, map, synthesize, and defend geospatial data in response to the annual TSA Geospatial Technology challenge.*

- Research the annual TSA Geospatial Technology challenge and identify the geographic issue or prediction being investigated.
- Collect geospatial data such as imagery, boundaries, transportation data, earth observations, historical maps, or basemaps.
- Use an online mapping platform to represent and analyze geospatial data.
- Prepare a digital documentation portfolio explaining the challenge, collected data, analysis maps, prediction, resources, and work log.
- Create a visual infographic map that communicates the predicted outcome and clearly supports it with data.
- Present and defend the team's prediction during the semifinal presentation/interview.
- Evaluate the final entry using TSA criteria for data use, prediction quality, visual communication, analysis, creativity, and presentation.

Resources

- Technology Student Association – Geospatial Technology competition guidelines https://tsaweb.org/competitions-programs/tsa/themes-problems
- ArcGIS Online – Mapping and geospatial analysis tools https://www.arcgis.com/
- NASA Earthdata – Earth observation and geospatial data https://www.earthdata.nasa.gov/
- QGIS – Open-source geospatial analysis software https://qgis.org/

Technology Student Association – National Competitive Events

Debating Technological Issues

Objective: *Students will research, document, organize, and defend evidence-based arguments about technological issues in alignment with TSA Debating Technological Issues competition requirements.*

- Research the annual TSA debate topic and related subtopics from credible sources.
- Prepare a one-page summary of references using MLA format according to TSA competition requirements.
- Develop evidence-based pro and con arguments for multiple technological issue subtopics.
- Organize claims, evidence, reasoning, cross-examination questions, and rebuttal points for timed debate rounds.
- Use clear, concise, and persuasive language appropriate for a formal debate setting.
- Respond to opposing arguments through questioning, analysis, and rebuttal.
- Evaluate debate performance using TSA criteria for research, argument quality, communication, reasoning, and professionalism.

Resources

- Technology Student Association – Debating Technological Issues competition guidelines https://tsaweb.org/competitions-programs/tsa/themes-problems
- Federal Aviation Administration – Unmanned Aircraft Systems https://www.faa.gov/uas
- Purdue OWL – MLA Formatting and Style Guide https://owl.purdue.edu/owl/researchandcitation/mlastyle/mlaformattingandstyleguide/
- National Speech & Debate Association – Debate resources https://www.speechanddebate.org/